provided in the listing. MSHA will notify the public of each equivalency determination and will publish a summary of the basis for its determination. MSHA will provide equivalency determination reports to the public upon request to the Approval and Certification Center.

(d) After MSHA has determined that non-MSHA product safety standards are equivalent and has notified the public of such determinations, applicants may seek MSHA product approval based on such non-MSHA product safety standards.

[68 FR 36417, June 17, 2003, as amended at 73 FR 80609, Dec. 31, 2008]

§ 6.30 MSHA listing of equivalent non-MSHA product safety standards.

MSHA evaluated the following non-MSHA product safety standards and determined that they provide at least the same degree of protection as current MSHA requirements with or without modifications as indicated:

(a) The International Electrotechnical Commission's (IEC) standards for Electrical Apparatus for Explosive Gas Atmospheres, Part 0, General Requirements (IEC 60079–0, Fourth Edition, 2004–01) and Part 1, Electrical Apparatus for Explosive Gas Atmospheres, Flameproof Enclosures ''d'' (IEC 60079–1, Fifth Edition, 2003–11) must be modified in order to provide at least the same degree of protection as MSHA explosion-proof enclosure requirements included in parts 7 and 18 of this chapter. Refer to §§ 7.10(c)(1) and 18.6(a)(3)(i) for a list of the required modifications. The IEC standards may be inspected at the U.S. Department of Labor, Mine Safety and Health Administration, Electrical Safety Division, Approval and Certification Center, 765 Technology Drive, Triadelphia, WV 26059, and may be purchased from International Electrical Commission, Central Office 3, rue de Varembé, P.O. Box 131, CH–1211 GENEVA 20, Switzerland.

(b) [Reserved]

[71 FR 28583, May 17, 2006, as amended at 73 FR 52210, Sept. 9, 2008]

PART 7—TESTING BY APPLICANT OR THIRD PARTY

Subpart A—General

Sec.

Subpart B—Brattice Cloth and Ventilation Tubing

Subpart C—Battery Assemblies

Subpart D—Multiple-Shot Blasting Units

Subpart E—Diesel Engines Intended for Use in Underground Coal Mines

Subpart F—Diesel Power Packages Intended for Use in Areas of Underground Coal Mines Where Permissible Electric Equipment Is Required

Subpart J—Electric Motor Assemblies

Subpart K—Electric Cables, Signaling Cables, and Cable Splice Kits

Subpart L—Refuge Alternatives

AUTHORITY: 30 U.S.C. 957.

SOURCE: 53 FR 23500, June 22, 1988, unless otherwise noted.

Subpart A—General

§7.1 Purpose and scope.

This part sets out requirements for MSHA approval of certain equipment and materials for use in underground mines whose product testing and evaluation does not involve subjective analysis. These requirements apply to products listed in the subparts following this Subpart A. After the dates specified in the following subparts, requests for approval of products shall be made in accordance with this Subpart A and the applicable subpart.

§7.2 Definitions.

The following definitions apply in this part.

Applicant. An individual or organization that manufactures or controls the assembly of a product and that applies to MSHA for approval of that product.

Approval. A document issued by MSHA which states that a product has met the requirements of this part and which authorizes an approval marking identifying the product as approved.

Authorized company official. An individual designated by applicant who has the authority to bind the company.

Critical characteristic. A feature of a product that, if not manufactured as approved, could have a direct adverse effect on safety and for which testing or inspection is required prior to shipment to ensure conformity with the technical requirements under which the approval was issued.

Equivalent non-MSHA product safety standards. A non-MSHA product safety standard, or group of standards, that is determined by MSHA to provide at least the same degree of protection as the applicable MSHA product technical requirements in the subparts of this part, or can be modified to provide at least the same degree of protection as those MSHA requirements.

Extention of approval. A document issued by MSHA which states that the change to a product previously approved by MSHA under this part meets the requirements of this part and which authorizes the continued use of the approval marking after the appropriate extension number has been added.

Post-approval product audit. Examination, testing, or both, by MSHA of approved products selected by MSHA to determine whether those products meet the applicable technical requirements and have been manufactured as approved.

Technical requirements. The design and performance requirements for a product, as specified in a subpart of this part.

Test procedures. The methods specified in a subpart of this part used to determine whether a product meet the performance portion of the technical requirements.

[53 FR 23500, June 22, 1988; 53 FR 25569, July 7, 1988, as amended at 68 FR 36418, June 17, 2003]

§ 7.3 Application procedures and requirements.

(a) *Application.* Requests for an approval or extension of approval shall be sent to: U.S. Department of Labor, Mine Safety and Health Administration, Approval and Certification Center, 765 Technology Drive, Triadelphia, WV 26059.

(b) *Fees.* Fees calculated in accordance with part 5 of this title shall be submitted in accordance with § 5.40.

(c) *Original approval.* Each application for approval of a product shall include—

(1) A brief description of the product;

(2) The documentation specified in the appropriate subpart of this part;

(3) The name, address, and telephone number of the applicant's representative responsible for answering any questions regarding the application;

(4) If appropriate, a statement indicating whether, in the applicant's opinion, testing is required. If testing is not proposed, the applicant shall explain the reasons for not testing; and

(5) If appropriate, the place and date for product testing.

(d) *Subsequent approval of a similar product.* Each application for a product similar to one for which the applicant already holds an approval shall include—

(1) The approval number for the product which most closely resembles the new one;

(2) The information specified in paragraph (c) of this section for the new product, except that any document which is the same as one listed by MSHA in prior approvals need not be submitted, but shall be noted in the application;

(3) An explanation of any change from the existing approval; and

(4) A statement as to whether, in the applicant's opinion, the change requires product testing. If testing is not proposed, the applicant shall explain the reasons for not testing.

(e) *Extension of an approval.* Any change in the approved product from the documentation on file at MSHA that affects the technical requirements of this part shall be submitted to MSHA for approval prior to implementing the change. Each application for an extension of approval shall include—

(1) The MSHA-assigned approval number for the product for which the extension is sought;

(2) A brief description of the proposed change to the previously approved product;

(3) Drawings and specifications which show the change in detail;

(4) A statement as to whether, in the applicant's opinion, the change requires product testing. If testing is not proposed, the applicant shall explain the reasons for not testing;

(5) The place and date for product testing, if testing will be conducted; and

(6) The name, address, and telephone number of the applicant's representative responsible for answering any questions regarding the application.

(f) *Certification statement.* (1) Each application for original approval, subsequent approval, or extension of approval of a product shall include a certification by the applicant that the product meets the design portion of the technical requirements, as specified in the appropriate subpart, and that the applicant will perform the quality assurance functions specified in § 7.7. For a subsequent approval or extension of approval, the applicant shall also certify that the proposed change cited in the application is the only change that affects the technical requirements.

(2) After completion of the required product testing, the applicant shall certify that the product has been tested and meets the performance portion of the technical requirements, as specified in the appropriate subpart.

(3) All certification statements shall be signed by an authorized company official.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33722, June 29, 1995; 73 FR 52210, Sept. 9, 2008]

§ 7.4 Product testing.

(a) All products submitted for approval under this part shall be tested using the test procedures specified in the appropriate subpart unless MSHA determines, upon review of the documentation submitted, that testing is not required. Applicants shall maintain records of test results and procedures for three years.

(b) Unless otherwise specified in the subpart, test instruments shall be calibrated at least as frequently as, and according to, the instrument manufacturer's specifications, using calibration standards traceable to those set by the National Bureau of Standards, U.S. Department of Commerce or other nationally recoginzed standards and accurate to at least one significant figure beyond the desired accuracy.

(c) When MSHA elects to observe product testing, the applicant shall permit an MSHA official to be present at a mutually agreeable date, time, and place.

(d) MSHA will accept product testing conducted outside the United States where such acceptance is specifically required by international agreement.

[53 FR 23500, June 22, 1988; 53 FR 25569, July 7, 1988; 60 FR 33722, June 29, 1995]

§ 7.5 Issuance of approval.

(a) An applicant shall not advertise or otherwise represent a product as approved until MSHA has issued the applicant an approval.

(b) MSHA will issue an approval or a notice of the reasons for denying approval after reviewing the application, and the results of product testing, when applicable. An approval will identify the documents upon which the approval is based.

§ 7.6 Approval marking and distribution record.

(a) Each approved product shall have an approval marking, as specified in the appropriate subpart of this part.

(b) For an extension of approval, the extension number shall be added to the original approval number on the approval marking.

(c) Applicants shall maintain records of the initial sale of each unit having an approval marking. The record retention period shall be at least the expected shelf life and service life of the product.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33722, June 29, 1995]

§ 7.7 Quality assurance.

Applicants granted an approval or an extension of approval under this part shall—

(a) Inspect or test, or both, the critical characteristics in accordance with the appropriate subpart of this part;

(b) Unless otherwise specified in the subparts, calibrate instruments used for the inspection and testing of critical characteristics at least as frequently as, and according to, the instrument manufacturer's specifications, using calibration standards traceable to those set by the National Bureau of Standards, U.S. Department of Commerce or other nationally recognized standards and use instruments accurate to at least one significant figure beyond the desired accuracy.

(c) Control production documentation so that the product is manufactured as approved;

(d) Immediately report to the MSHA Approval and Certification Center, any knowledge of a product distributed with critical characteristics not in accordance with the approval specifications.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33722, June 29, 1995]

§ 7.8 Post-approval product audit.

(a) Approved products shall be subject to periodic audits by MSHA for the purpose of determining conformity with the technical requirements upon which the approval was based. Any approved product which is to be audited shall be selected by MSHA and be representative of those distributed for use in mines. The approval-holder may obtain any final report resulting from such audit.

(b) No more than once a year except for cause, the approval-holder, at MSHA's request, shall make an approved product available at no cost to MSHA for an audit to be conducted at a mutually agreeable site and time. The approval-holder may observe any tests conducted during this audit.

(c) An approved product shall be subject to audit for cause at any time MSHA believes that it is not in compliance with the technical requirements upon which the approval was based.

§ 7.9 Revocation.

(a) MSHA may revoke for cause an approval issued under this part if the product:

(1) Fails to meet the applicable technical requirements; or

(2) Creates a hazard when used in a mine.

(b) Prior to revoking an approval, the approval-holder shall be informed in writing of MSHA's intention to revoke approval. The notice shall:

(1) Explain the specific reasons for the proposed revocation; and

(2) Provide the approval-holder an opportunity to demonstrate or achieve compliance with the product approval requirements.

(c) Upon request, the approval-holder shall be afforded an opportunity for a hearing.

(d) If a product poses an imminent hazard to the safety or health of miners, the approval may be immediately suspended without a written notice of the agency's intention to revoke. The suspension may continue until the revocation proceedings are completed.

§ 7.10 MSHA acceptance of equivalent non-MSHA product safety standards.

(a) MSHA will accept non-MSHA product safety standards, or groups of standards, as equivalent after determining that they:

(1) Provide at least the same degree of protection as MSHA's applicable technical requirements for a product in the subparts of this part; or

(2) Can be modified to provide at least the same degree of protection as those MSHA requirements.

(b) MSHA will publish its intent to review any non-MSHA product safety standard for equivalency in the FEDERAL REGISTER for the purpose of soliciting public input.

(c) A listing of all equivalency determinations will be published in this part 7. The listing will state whether MSHA accepts the non-MSHA product safety standards in their original form, or whether MSHA will require modifications to demonstrate equivalency. If modifications are required, they will be provided in the listing. MSHA will notify the public of each equivalency determination and will publish a summary of the basis for its determination. MSHA will provide equivalency determination reports to the public upon request to the Approval and Certification Center. MSHA has made the following equivalency determinations applicable to this part 7.

(1) MSHA will accept applications for motors under Subpart J designed and tested to the International Electrotechnical Commission's (IEC) standards for Electrical Apparatus for Explosive Gas Atmospheres, Part 0, General Requirements (IEC 60079–0, Fourth Edition, 2004–01) and Part 1, Electrical Apparatus for Explosive Gas Atmospheres, Flameproof Enclosures ''d'' (IEC 60079–1, Fifth Edition, 2003–11) (which are hereby incorporated by reference and made a part hereof) provided the modifications to the IEC

standards specified in § 7.10(c)(1)(i) through (ix) are met. The Director of the Federal Register approves this incorporation by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. The IEC standards may be inspected at the U.S. Department of Labor, Mine Safety and Health Administration, Electrical Safety Division, Approval and Certification Center, 765 Technology Drive, Triadelphia, WV 26059, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. These IEC standards may be obtained from International Electrical Commission, Central Office 3, rue de Varembé, P.O. Box 131, CH–1211 GENEVA 20, Switzerland.

(i) Enclosures associated with an electric motor assembly shall be made of metal and not have a compartment exceeding ten (10) feet in length. External surfaces of enclosures shall not exceed 150 °C (302 °F) in normal operation.

(ii) Enclosures shall be rugged in construction and should meet existing requirements for minimum bolt size and spacing and for minimum wall, cover, and flange thicknesses specified in paragraph (g)(19) of § 7.304 Technical requirements. Enclosure fasteners should be uniform in size and length, be provided at all corners, and be secured from loosening by lockwashers or equivalent. An engineering analysis shall be provided for enclosure designs that deviate from the existing requirements. The analysis shall show that the proposed enclosure design meets or exceeds the mechanical strength of a comparable enclosure designed to 150 psig according to existing requirements, and that flamepath clearances in excess of existing requirements will not be produced at an internal pressure of 150 psig. This shall be verified by explosion testing the enclosure at a minimum of 150 psig.

(iii) Enclosures shall be designed to withstand a minimum pressure of at least 150 psig without leakage through any welds or castings, rupture of any part that affects explosion-proof integrity, clearances exceeding those permitted under existing requirements along flame-arresting paths, or permanent distortion exceeding 0.040-inch per linear foot.

(iv) Flamepath clearances, including clearances between fasteners and the holes through which they pass, shall not exceed those specified in existing requirements. No intentional gaps in flamepaths are permitted.

(v) The minimum lengths of the flame arresting paths, based on enclosure volume, shall conform to those specified in existing requirements to the nearest metric equivalent value (e.g., 12.5 mm, 19 mm, and 25 mm are considered equivalent to ½ inch, ¾ inch and 1 inch respectively for plane and cylindrical joints). The widths of any grooves for o-rings shall be deducted in measuring the widths of flame-arresting paths.

(vi) Gaskets shall not be used to form any part of a flame-arresting path. If o-rings are installed within a flamepath, the location of the o-rings shall meet existing requirements.

(vii) Cable entries into enclosures shall be of a type that utilizes either flame-resistant rope packing material or sealing rings (grommets). If plugs and mating receptacles are mounted to an enclosure wall, they shall be of explosion-proof construction. Insulated bushings or studs shall not be installed in the outside walls of enclosures. Lead entrances utilizing sealing compounds and flexible or rigid metallic conduit are not permitted.

(viii) Unused lead entrances shall be closed with a metal plug that is secured by spot welding, brazing, or equivalent.

(ix) Special explosion tests are required for electric motor assemblies that share leads (electric conductors) through a common wall with another explosion-proof enclosure, such as a motor winding compartment and a conduit box. These tests are required to determine the presence of any pressure piling conditions in either enclosure when one or more of the insulating barriers, sectionalizing terminals, or other isolating parts are sequentially removed from the common wall between the enclosures. Enclosures that exhibit pressures during these tests that exceed those specified in existing requirements must be provided with a warning tag. The durable warning tag must indicate that the insulating barriers, sectionalizing terminals, or other isolating parts be maintained in order to insure the explosion-proof integrity for either enclosure sharing a common wall. A warning tag is not required if the enclosures withstand a static pressure of twice the maximum value observed in the explosion tests.

(2) [Reserved]

(d) After MSHA has determined that non-MSHA product safety standards are equivalent and has notified the public of such determinations, applicants may seek MSHA product approval based on such non-MSHA product safety standards.

[68 FR 36418, June 17, 2003, as amended at 71 FR 28583, May 17, 2006; 73 FR 52210, Sept. 9, 2008]

Subpart B—Brattice Cloth and Ventilation Tubing

§ 7.21 Purpose and effective date.

This subpart establishes the specific requirements for approval of brattice cloth and ventilation tubing. It is effective August 22, 1988. Applications for approval or extension of approval submitted after August 22, 1989, shall meet the requirements of this part.

§ 7.22 Definitions.

The following definitions apply in this subpart:

Brattice cloth. A curtain of jute, plastic, or similar material used to control or direct ventilating air.

Denier. A unit of yarn size indicating the fineness of fiber of material based on the number of grams in a length of 9,000 meters.

Film. A sheet of flexible material applied to a scrim by pressure, temperature, adhesion, or other method.

Scrim. A substrate material of plastic or fabric laminated between or coated with a film.

Ventilation tubing. Rigid or flexible tubing used to convey ventilating air.

§ 7.23 Application requirements.

(a) *Brattice cloth*. A single application may address two or more products if the products differ only in: weight of the finished product; weight or weave of the same fabric or scrim; or thickness or layers of the same film. Applications shall include the following information:

(1) Trade name.

(2) Product designations (for example, style and code number).

(3) Color.

(4) Type of brattice (for example, plastic or jute).

(5) Weight of finished product.

(6) Film: type, weight, thickness, supplier, supplier's stock number or designation, and percent of finished product by weight.

(7) Scrim: Type, denier, weight, weave, the supplier, supplier's stock number or designation, and percent of finished product by weight.

(8) Adhesive: type, supplier, supplier's stock number or designation, and percent of finished product by weight.

(b) *Flexible ventilation tubing*. Applications shall include the product description information in paragraph (a) of this section and list the type of supporting structure, if applicable; inside diameters; and configurations.

(c) *Rigid ventilation tubing*. A single application may address two or more products if the products differ only in diameters, lengths, configuration, or average wall thickness. Applications shall include the following information:

(1) Trade name.

(2) Product designations (for example, style and code numbers).

(3) Color.

(4) Type of ventilation tubing (for example, fiberglass, plastic, or polyethylene).

(5) Inside diameter, configuration, and average wall thickness.

(6) Suspension system (for example, metal hooks).

(7) Base material: type, supplier, the supplier's stock number, and percent of finished product by weight.

(8) Resin: type, supplier, the supplier's stock number, and percent of finished product by weight.

(9) Flame retardant, if added during manufacturing: type, supplier, the supplier's stock number, and percent of finished product by weight.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33722, June 29, 1995]

§ 7.24 Technical requirements.

(a) Brattice cloth shall be flame resistant when tested in accordance with the flame resistance test in § 7.27.

(b) Flexible ventilation tubing shall be manufactured using an MSHA-approved brattice cloth. If a supporting structure is used, it shall be metal or other noncombustible material which will not ignite, burn, support combustion or release flammable vapors when subjected to fire or heat.

(c) Rigid ventilation tubing shall be flame resistant when tested in accordance with the flame resistance test in § 7.28.

§ 7.25 Critical characteristics.

A sample of each batch or lot of brattice cloth and ventilation tubing shall be flame tested or a sample of each batch or lot of the materials that contribute to the flame-resistance characteristic shall be inspected or tested to ensure that the finished product will meet the flame-resistance test.

§ 7.26 Flame test apparatus.

The principal parts of the apparatus used to test for flame-resistance of brattice cloth and ventilation tubing shall be constructed as follows:

(a) A 16-gauge stainless steel gallery lined on the top, bottom and both sides with ½ inch thick Marinite or equivalent insulating material yielding inside dimensions approximately 58 inches long, 41 inches high, and 30 inches wide;

(b) Two ⅜-inch diameter steel J hooks and a 9⁄16-inch diameter steel rod to support the sample located approximately 2 3⁄16-inches from the front and back ends of the test gallery, 1½-inches from the ceiling insulation and centrally located in the gallery along its length. Samples shall be suspended to preclude folds or wrinkles;

(c) A tapered 16-gauge stainless steel duct section tapering from a cross sectional area measuring 2 feet 7 inches wide by 3 feet 6 inches high at the test gallery to a cross-sectional area 1 foot 6 inches square over a length of 3 feet. The tapered duct section must be tightly connected to the test gallery;

(d) A 16-gauge stainless steel fan housing, consisting of a 1 foot 6 inches square section 6 inches long followed by a 10 inch long section which tapers from 1 foot 16 inches square to 12 inches diameter round and concluding with a 12 inch diameter round collar 3 inches long. A variable speed fan capable of producing an air velocity of 125 ft./min. in the test gallery must be secured in the fan housing. The fan housing must be tightly connected to the tapered duct section;

(e) A methane-fueled impinged jet burner igniting source, measuring 12 inches long from the threaded ends of the first and last jets and 4 inches wide with 12 impinged jets, approximately 1⅜-inches long and spaced alternately along the length of the burner tube. The burner jets must be canted so that they point toward each other in pairs and the flame from these pairs impinge upon each other.

§ 7.27 Test for flame resistance of brattice cloth.

(a) *Test procedures.* (1) Prepare 6 samples of brattice cloth 40 inches wide by 48 inches long.

(2) Prior to testing, condition each sample for a minimum of 24 hours at a temperature of 70 ±10 °F (21 ±5.5 °C) and a relative humidity of 55 ±10%.

(3) For each test, suspend the sample in the gallery by wrapping the brattice cloth around the rod and clamping each end and the center. The brattice cloth must hang 4 inches from the gallery floor.

(4) Use a front exhaust system to remove smoke escaping from the gallery. The exhaust system must remain on during all testing, but not affect the air flow in the gallery.

(5) Set the methane-fueled impinged jet burner to yield a flame height of 12 inches as measured at the outermost tip of the flame.

(6) Apply the burner to the front lower edge of the brattice cloth and keep it in contact with the material for 25 seconds or until 1 foot of material, measured horizontally, is consumed, whichever occurs first. If the material

shrinks during application of the burner flame, move the burner flame to maintain contact with 1 foot of the material. If melting material might clog the burner orifices, rotate the burner slightly during application of the flame.

(7) Test 3 samples in still air and 3 samples with an average of 125 ft./min. of air flowing past the sample.

(8) Record the propagation length and duration of burning for each of the 6 samples. The duration of burning is the total burning time of the specimen during the flame test. This includes the burn time of any material that falls on the floor of the test gallery during the igniting period. However, the suspended specimen is considered burning only after the burner is removed. Should the burning time of a suspended specimen and a specimen on the floor coincide, count the coinciding burning time only once.

(9) Calculate the average duration of burning for the first 3 samples (still air) and the second 3 samples (125 ft./min. air flow).

(b) *Acceptable performance.* The brattice cloth shall meet each of the following criteria:

(1) Flame propagation of less than 4 feet in each of the six tests.

(2) An average duration of burning of less than 1 minute in both groups of three tests.

(3) A duration of burning not exceeding two minutes in each of the six tests.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33723, June 29, 1995]

§ 7.28 Test for flame resistance of rigid ventilation tubing.

(a) *Test procedures.* (1) Prepare 6 samples of ventilation tubing 48 inches in length with all flared or thickened ends removed. Any sample with a cross-sectional dimension greater than 24 inches must be tested in a 24-inch size.

(2) For each test, suspend the sample in the center of the gallery by running a wire through the 48-inch length of tubing.

(3) Use a front exhaust system to remove smoke escaping from the gallery. The exhaust system must remain on during all testing but not affect the air flow in the gallery.

(4) Set the methane-fueled impinged jet burner to yield a flame height of 12 inches as measured at the outermost tip of the flame.

(5) Apply the burner to the front lower edge of the tubing so that two-thirds of the burner is under the tubing and the remaining third is exposed to allow the flames to curl onto the inside of the tubing. Keep the burner in contact with the material for 60 seconds. If melting material might clog the burner orifices, rotate the burner slightly during application of the flame.

(6) Test 3 samples in still air and 3 samples with an average of 125 ft./min. of air flowing past the sample.

(7) Record the propagation length and duration of burning for each of the 6 samples. The duration of burn is the total burning time of the specimen during the flame test. This includes the burning time of any material that falls on the floor of the test gallery during the igniting period. However, the suspended specimen is considered burning only after the burner is removed. Should the burning time of a suspended specimen and a specimen on the floor coincide, count the coinciding burn time only once.

(8) Calculate the average duration of burning for the first 3 samples (still air) and the second 3 samples (125 ft./min. air flow).

(b) *Acceptable performance.* The ventilation tubing shall meet each of the following criteria:

(1) Flame propagation of less than 4 feet in each of the 6 tests.

(2) An average duration of burning of less than 1 minute in both groups of 3 tests.

(3) A duration of burning not exceeding 2 minutes in each of the 6 tests.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33723, June 29, 1995]

§ 7.29 Approval marking.

(a) Approved brattice cloth shall be legibly and permanently marked with the assigned MSHA approval number at intervals not exceeding ten feet. If the nature of the material or method of processing makes such marking impractical, permanent paint or ink may be used to mark the edge with an MSHA-assigned color code.

(b) Approved ventilation tubing shall be legibly and permanently marked on each section with the assigned MSHA approval number.

(c) An approved product shall be marketed only under a brand or trade name that has been furnished to MSHA.

§ 7.30 Post-approval product audit.

Upon request by MSHA but no more than once a year except for cause, the approval-holder shall supply to MSHA at no cost up to fifty feet of each approved design of brattice cloth and ventilation tubing for audit.

§ 7.31 New technology.

MSHA may approve brattice cloth and ventilation tubing that incorporates technology for which the requirements of this subpart are not applicable, if the Agency determines that the product is as safe as those which meet the requirements of this subpart.

Subpart C—Battery Assemblies

§ 7.41 Purpose and effective date.

This subpart establishes the specific requirements for MSHA approval of battery assemblies intended for incorporation in approved equipment in underground mines. It is effective August 22, 1988. Applications for approval or extensions of approval submitted after August 22, 1989, shall meet the requirements of this part.

§ 7.42 Definitions.

The following definitions apply in this subpart:

Battery assembly. A unit or units consisting of cells and their electrical connections, assembled in a battery box or boxes with covers.

Battery box. The exterior sides, bottom, and connector receptacle compartment, if any, of a battery assembly, excluding internal partitions.

§ 7.43 Application requirements.

(a) An application for approval of a battery assembly shall contain sufficient information to document compliance with the technical requirements of this subpart and include a composite drawing with the following information:

(1) Overall dimensions of the battery assembly, including the minimum distance from the underside of the cover to the top of the terminals and caps.

(2) Composition and thicknesses of the battery box and cover.

(3) Provision for securing covers.

(4) Documentation of flame-resistance of insulating materials and cables.

(5) Number, type, and rating of the battery cells.

(6) Diagram of battery connections between cells and between battery boxes, except when connections between battery boxes are a part of the machine's electrical system.

(7) Total weight of the battery, charged and ready for service.

(8) Documentation of materials and configurations for battery cells, intercell connectors, filler caps, and battery top:

(i) If nonmetallic cover designs are used with cover support blocks; or

(ii) If the cover comes into contact with any portion of the cells, caps, filler material, battery top, or intercell connectors during the impact test specified by § 7.46.

(b) All drawings shall be titled, dated, numbered, and include the latest revision number.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33723, June 29, 1995]

§ 7.44 Technical requirements.

(a)(1) Battery boxes and covers constructed of AISI 1010 hot rolled steel shall have the following minimum thicknesses based on the total weight of a unit of the battery assembly charged and ready for service:

Weight of battery unit	Minimum required thickness
1,000 lbs. maximum	10 gauge or 1⁄8″ nominal
1,001 to 2,000 lbs	7 gauge or 3⁄16″ nominal
2,001 to 4,500 lbs	3 gauge or 1⁄4″ nominal
Over 4,500 lbs	0 gauge or 5⁄16″ nominal

(2) Battery boxes not constructed of AISI 1010 hot rolled steel shall have at least the tensile strength and impact resistance of battery boxes for the same weight class, as listed in paragraph (a)(1) of this section.

(3) Battery box covers constructed of materials with less than the tensile

strength and impact resistance of AISI 1010 hot rolled steel or constructed of nonmetallic materials shall meet the acceptable performance criteria for the impact test in § 7.46. Nonmetallic covers shall be used only in the battery assembly configuration in which they pass the impact test.

(4) Nonmetallic materials for boxes and covers shall—

(i) Be accepted by MSHA as flame-resistant material under part 18 of this chapter; and

(ii) Meet the acceptable performance criteria for the deflection temperature test in § 7.47.

(b) All insulating material shall have a minimum resistance of 100 megohms at 500 volts d.c. and be accepted by MSHA as flame resistant under part 18 of this chapter.

(c) Battery box and cover insulating material shall meet the acceptable performance criteria for the acid resistance test in § 7.48.

(d) Covers shall be lined with insulating material permanently attached to the underside of the cover, unless the cover is constructed of insulating material.

(e) Covers, including those used over connector receptacle housings, shall be provided with a means of securing them in a closed position.

(f) Battery boxes shall be provided with vent openings to prevent the accumulation of flammable or toxic gases or vapors within the battery assembly. The size and location of openings shall prevent direct access to cell terminals and other uninsulated current carrying parts. The total minimum unobstructed cross-sectional area of the ventilation openings shall be no less than the value determined by the following formula:

$$\frac{(N)(R)}{950} = M$$

N = Number of cells in battery box.

R = Rated 6 hour battery capacity in ampere hours.

M = Total minimum ventilation area in square inches per battery box.

(g) Battery boxes shall have drainage holes to prevent accumulation of water or electrolyte.

(h) Battery cells shall be insulated from the battery box walls, partitions and bottom by insulating material, unless such part of the battery box is constructed of insulating material. Battery box wall insulating material shall extend to the top of the wall.

(i) Cell terminals shall be burned on, except that bolted connectors using two or more bolts may be used on end terminals.

(j) Battery connections shall be designed so that total battery potential is not available between adjacent cells.

(k) Cables within a battery box shall be accepted by MSHA as flame resistant under part 18 of this chapter or approved under subpart K of this part. The cables shall be protected against abrasion by insulation, location, clamping, or other effective means.

(l) When the battery plug and receptacle are not located on or within the battery box, strain on the battery terminals shall be prevented by a strain-relief device on the cable. Insulating material shall be placed between the strain-relief device and cable, unless the device is constructed of insulating material.

(m) At least a ½-inch air space shall be provided between the underside of the battery cover and the top of the battery, including the terminals and connectors.

[53 FR 23500, June 22, 1988, as amended at 57 FR 61220, Dec. 23, 1992]

§ 7.45 Critical characteristics

The following critical characteristics shall be inspected or tested on each battery assembly to which an approval marking is affixed:

(a) Thickness of covers and boxes.

(b) Application and resistance of insulating material.

(c) Size and location of ventilation openings.

(d) Method of cell terminations.

(e) Strain relief devices for cables leaving boxes.

(f) Type, location, and physical protection of cables.

§ 7.46 Impact test.

(a) *Test procedures.* (1) Prepare four covers for testing by conditioning two covers at −13 °F (−25 °C) and two covers at 122 °F (50 °C) for a period of 48 hours.

(2) Mount the covers on a battery box of the same design with which the covers are to be approved, including any support blocks, with the battery cells completely assembled. If used, support blocks must contact only the filler material or partitions between the individual cells. At the test temperature range of 65 °F –80 °F (18.3 °C–26.7 °C), apply a dynamic force of 200 ft. lbs. to the following areas using a hemispherical weight with a 6″ maximum radius:

(i) The center of the two largest unsupported areas;

(ii) The areas above at least two support blocks, if used;

(iii) The areas above at least two intercell connectors, one cell, and one filler cap; and

(iv) Areas on at least two corners. If the design consists of both inside and outside corners, test one of each.

(3) Record the condition of the covers, supports, intercell connectors, filler caps, cell covers, and filler material.

(b) *Acceptable performance.* Impact tests of any of the four covers shall not result in any of the following:

(1) Bent intercell connectors.

(2) Cracked or broken filler caps, except plastic tabs which extend from the body of the filler caps.

(3) Cracks in the cell cover, cells, or filler material.

(4) Cracked or bent supports.

(5) Cracked or splintered battery covers.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33723, June 29, 1995]

§ 7.47 Deflection temperature test.

(a) *Test procedures.* (1) Prepare two samples for testing that measure 5 inches by ½ inch, by the thickness of the material as it will be used. Prior to testing, condition the samples at 73.4 ± 3.6 °F (23 ±2 °C) and 50 ±5% relative humidity for at least 40 hours.

(2) Place a sample on supports which are 4 inches apart and immersed in a heat transfer medium at a test temperature range of 65 °F − 80 °F (18.3 °C − 26.7 °C). The heat transfer medium must be a liquid which will not chemically affect the sample. The testing apparatus must be constructed so that expansion of any components during heating of the medium does not result in deflection of the sample.

(3) Place a temperature measuring device with an accuracy of 1% into the heat transfer medium within ⅛ inch of, but not touching, the sample.

(4) Apply a total load, in pounds, numerically equivalent to 11 times the thickness of the sample, in inches, to the sample midway between the supports using a ⅛ inch radius, rounded contact. The total load includes that weight used to apply the load and any force exerted by the deflection measurement device.

(5) Use a deflection measuring device with an accuracy of ±.001 inches to measure the deflection of the sample at the point of loading as the temperature of the medium is increased at a uniform rate of 3.6 ±.36 °F/min. (2 ±0.2 °C/min.). Apply the load to the sample for 5 minutes prior to heating, to allow compensation for creep in the sample due to the loading.

(6) Record the deflection of the sample due to heating at 180 °F (82 °C).

(7) Repeat steps 2 through 6 for the other sample.

(b) *Acceptable performance.* Neither sample shall have a deflection greater than .010 inch at 180 °F (82 °C).

[53 FR 23500, June 22, 1988; 53 FR 25569, July 7, 1988; 60 FR 33723, June 29, 1995]

§ 7.48 Acid resistance test.

(a) *Test procedures.* (1) Prepare one sample each of the insulated surfaces of the battery box and of the cover that measure at least 4 inches by 8 inches, by the thickness of the sample which includes the insulation plus the battery cover or box material. The insulation thickness shall be representative of that used on the battery box and cover. If the insulation material and thickness of material are identical for the battery box and cover, only one sample need be prepared and tested.

(2) Prepare a 30 percent solution of sulfuric acid (H_2SO_4) by mixing 853 ml of water with 199 ml of sulfuric acid (H_2SO_4) with a specific gravity of 1.84. Completely cover the samples with the acid solution at the test temperature range of 65 °F − 80 °F (18.3 °C − 26.7 °C) and maintain these conditions for 7 days.

(3) After 7 days, record the condition of the samples.

(b) *Acceptable performance.* At the end of the test, the insulation shall not exhibit any blistering, discoloration, cracking, swelling, tackiness, rubberiness, or loss of bond.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33723, June 29, 1995]

§ 7.49 Approval marking.

Each approved battery assembly shall be identified by a legible and permanent approval plate inscribed with the assigned MSHA approval number and securely attached to the battery box.

§ 7.50 Post-approval product audit.

Upon request by MSHA, but no more than once a year except for cause, the approval-holder shall make an approved battery assembly available for audit at no cost to MSHA.

§ 7.51 Approval checklist.

Each battery assembly bearing an MSHA approval plate shall be accompanied by a description of what is necessary to maintain the battery assembly as approved.

[53 FR 23500, June 22, 1988, as amended at 60 FR 33723, June 29, 1995]

§ 7.52 New technology.

MSHA may approve a battery assembly that incorporates technology for which the requirements of this subpart are not applicable, if the Agency determines that the battery assembly is as safe as those which meet the requirements of this subpart.

Subpart D—Multiple-Shot Blasting Units

SOURCE: 54 FR 48210, Nov. 21, 1989, unless otherwise noted.

§ 7.61 Purpose and effective date.

This subpart establishes the specific requirements for MSHA approval of multiple-shot blasting units. It is effective January 22, 1990. Applications for approval or extensions of approval submitted after January 22, 1991 shall meet the requirements of this subpart.

§ 7.62 Definitions.

The following definitions apply in this subpart:

Blasting circuit. A circuit that includes one or more electric detonators connected in a single series and the firing cable used to connect the detonators to the blasting unit.

Blasting unit. An electric device used to initiate electric detonators.

Normal operation. Operation of the unit according to the manufacturer's instructions with fully-charged batteries, with electric components at any value within their specified tolerances, and with adjustable electric components set to any value within their range.

§ 7.63 Application requirements.

(a) Each application for approval of a blasting unit shall include the following:

(1) An overall assembly drawing showing the physical construction of the blasting unit.

(2) A schematic diagram of the electric circuit.

(3) A parts list specifying each electric component and its electrical ratings, including tolerances.

(4) A layout drawing showing the location of each component and wiring.

(5) The model number or other manufacturer's designation of the blasting unit.

(b) All drawings shall be titled, numbered, dated, and include the latest revision number. The drawings may be combined into one or more composite drawings.

(c) The application shall contain a list of all the drawings submitted, including drawing titles, numbers, and revisions.

(d) A detailed technical description of the operation and use of the blasting unit shall be submitted with the application.

[54 FR 48210, Nov. 21, 1989, as amended at 60 FR 33723, June 29, 1995]

§ 7.64 Technical requirements.

(a) *Energy output.* Blasting units shall meet the acceptable performance criteria of the output energy test in § 7.66.

(b) *Maximum blasting circuit resistance.* The maximum value of the resistance of the blasting circuit that can be connected to the firing line terminals of the blasting unit, without exceeding its capacity, shall be specified by the applicant. The specified maximum blasting circuit resistance shall be at least 150 ohms.

(c) *Visual indicator.* The blasting unit shall provide a visual indication to the user prior to the operation of the firing switch when the voltage necessary to produce the required firing current is attained.

(d) *Firing switch.* The switch used to initiate the application of energy to the blasting circuit shall—

(1) Require deliberate action for its operation to prevent accidental firing; and

(2) Operate only when the voltage necessary to produce the required firing current is available to the blasting circuit.

(e) *Firing line terminals.* The terminals used to connect the blasting circuit to the blasting unit shall—

(1) Provide a secure, low-resistance connection to the blasting circuit as demonstrated by the firing line terminals test in § 7.68;

(2) Be corrosion-resistant;

(3) Be insulated to protect the user from electrical shock; and

(4) Be separated from each other by an insulated barrier.

(f) *Ratings of electric components.* No electric component of the blasting unit, other than batteries, shall be operated at more than 90 percent of any of its electrical ratings in the normal operation of the blasting unit.

(g) *Non-incendive electric contacts.* In the normal operation of a blasting unit, the electric energy discharged by making and breaking electric contacts shall not be capable of igniting a methane-air atmosphere, as determined by the following:

(1) The electric current through an electric contact shall not be greater than that determined from Figure D–1.

(2) The maximum voltage that can be applied across an electric contact that discharges a capacitor shall not be greater than that determined from Figure D–2.

(3) The electric current through an electric contact that interrupts a circuit containing inductive components shall not be greater than that determined from Figure D–3. Inductive components include inductors, chokes, relay coils, motors, transformers, and similar electric components that have an inductance greater than 100 microhenries. No inductive component in a circuit with making and breaking electric contacts shall have an inductance value greater than 100 millihenries.

FIGURE D–1

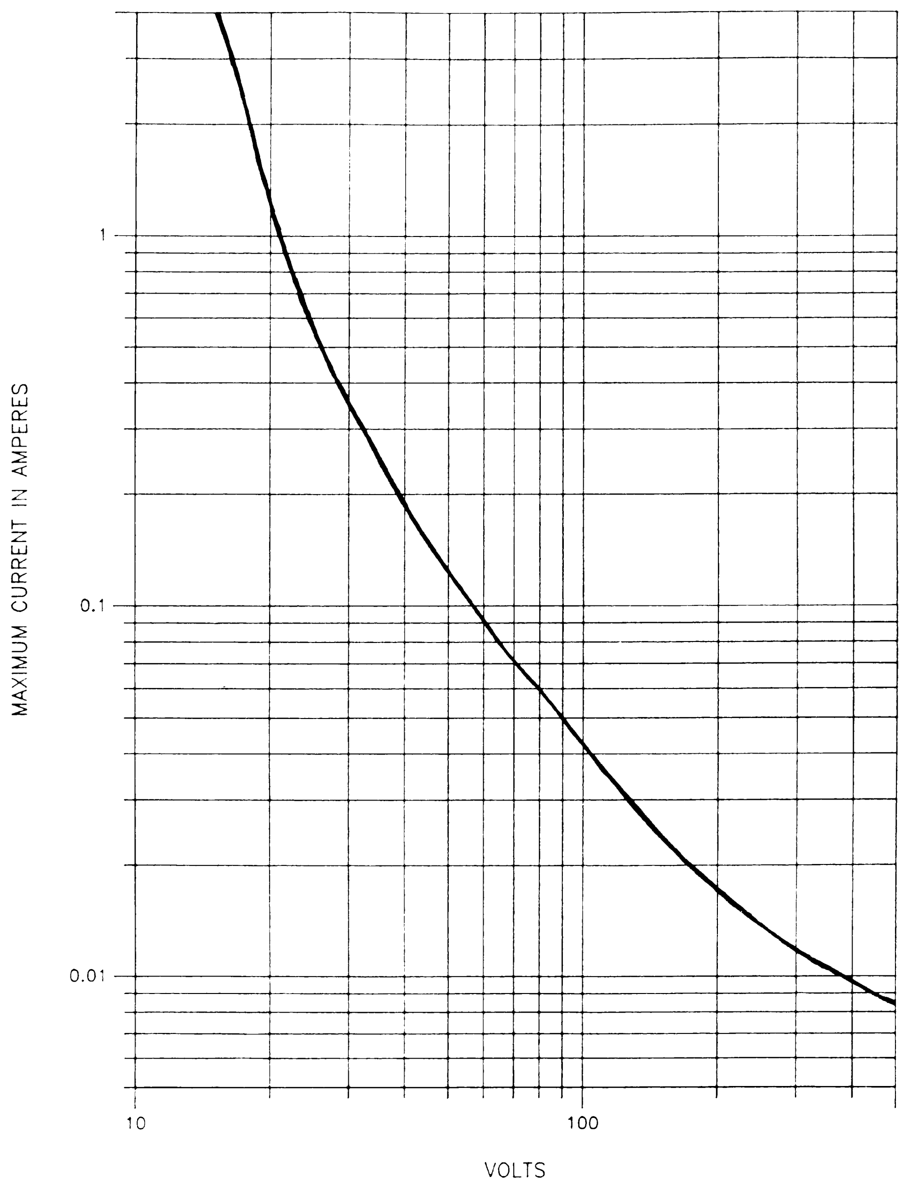


FIGURE D–2

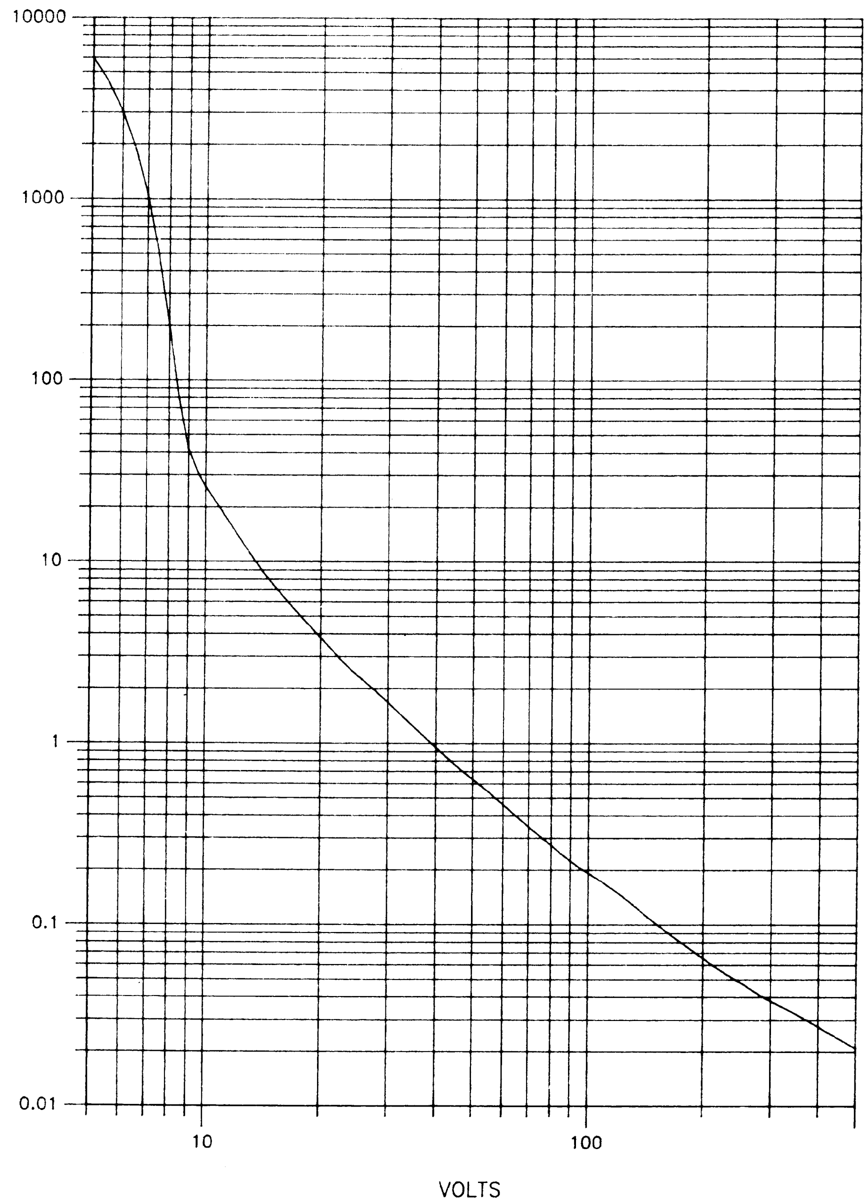
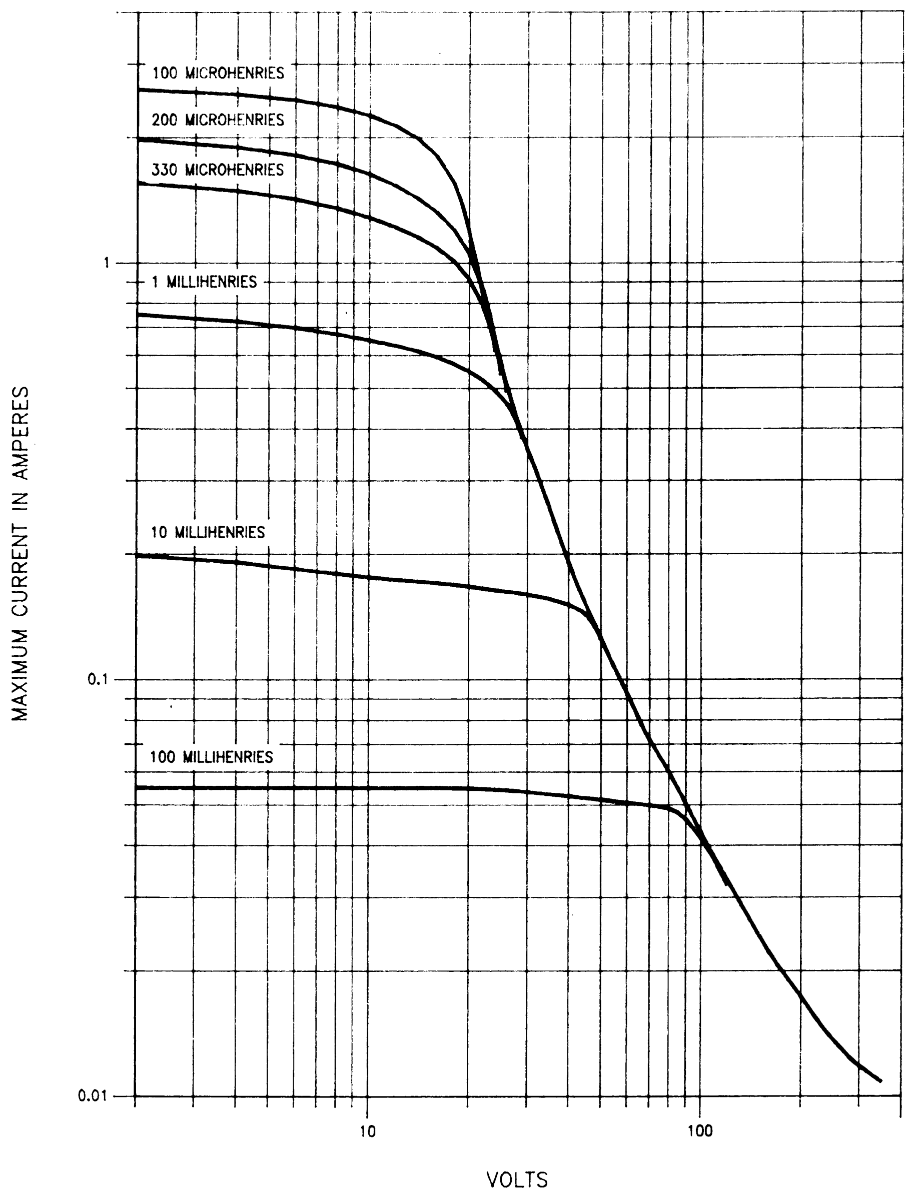


FIGURE D–3



(h) *Maximum temperature.* In the normal operation of the blasting unit, the maximum temperature of any electric component shall not exceed 302 °F (150 °C).

(i) *Capacitor discharge.* The blasting unit shall include an automatic means to dissipate any electric charge remaining in any capacitor after the blasting unit is deenergized and not in use.

(j) *Construction.* Blasting units shall meet the acceptable performance criteria of the construction test of § 7.67.

(k) *Locking device.* The blasting unit shall be equipped with a locking device to prevent unauthorized use.

(l) *Enclosure.* The blasting unit enclosure shall be protected against tampering by—

(1) Sealing the enclosure, except the battery compartment, using continuous welding, brazing, soldering, or equivalent methods; or

(2) Sealing the electric components, other than batteries, in a solidified insulating material and assembling the enclosure with tamper-resistant hardware.

(m) *Battery charging.* Blasting units that contain rechargeable batteries shall have the following:

(1) A blocking diode, or equivalent device, in series with the battery to prevent electric energy in the battery from being available at the charging connector.

(2) The charging connector recessed into the enclosure.

§ 7.65 Critical characteristics.

The following critical characteristics shall be inspected or tested on each blasting unit to which an approval marking is affixed:

(a) The output current.

(b) The voltage cut-off time.

(c) The components that control voltage and current through each making and breaking electric contact.

(d) Operation of the visual indicator and the firing switch.

§ 7.66 Output energy test.

(a) *Test procedures.* The blasting unit shall be tested by firing into each of the following resistive loads, within a tolerance of ±1%:

(1) The maximum blasting circuit resistance.

(2) Any resistive load between 3 ohms and the maximum blasting circuit resistance.

(3) One ohm.

(b) *Acceptable performance.* (1) The voltage shall be zero at the firing line terminals 10 milliseconds after operation of the firing switch.

(2) The electric current from the blasting unit shall be:

(i) Less than 50 milliamperes except during firing of the blasting unit.

(ii) Available only through the firing line terminals.

(iii) At least an average of 2 amperes during the first 5 milliseconds following operation of the firing switch.

(iv) Not exceed an average of 100 amperes during the first 10 milliseconds following operation of the firing switch.

§ 7.67 Construction test.

The constuction test is to be performed on the blasting unit subsequent to the output energy test of § 7.66.

(a) *Test procedures.* (1) The blasting unit shall be dropped 20 times from a height of 3 feet onto a horizontal concrete floor. When dropped, the orientation of the blasting unit shall be varied each time in an attempt to have a different surface, corner, or edge strike the floor first for each drop.

(2) After the blasting unit has been drop tested in accordance with paragraph (a)(1) above, it shall be submerged in 1 foot of water for 1 hour in each of 3 tests. The water temperature shall be maintained within ±5 °F (±2.8 °C) of 40 °F (4.4 °C), 70 °F (21.1 °C) and 100 °F (37.8 °C) during the tests.

(3) Immediately after removing the blasting unit from the water at each temperature, the unit shall be operated first with the firing line terminals open circuited, then operated again with the firing line terminals short circuited, and last, the output energy tested in accordance with the output energy test of § 7.66.

(b) *Acceptable performance.* (1) The blasting unit shall meet the acceptable performance criteria of the output energy test in § 7.66 each time it is performed.

(2) There shall be no damage to the firing line terminals that exposes an electric conductor.

(3) The visual indicator shall be operational.

(4) The batteries shall not be separated from the blasting unit.

(5) There shall be no water inside the blasting unit enclosure, except for the battery compartment.

§ 7.68 Firing line terminals test.

(a) *Test procedures.* (1) The contact resistance through each firing line terminal shall be determined.

(2) A 10-pound pull shall be applied to a No. 18 gauge wire that has been connected to each firing line terminal according to the manufacturer's instructions.

(b) *Acceptable performance.* (1) The contact resistance shall not be greater than 1 ohm.

(2) The No. 18 gauge wire shall not become disconnected from either firing line terminal.

§ 7.69 Approval marking.

Each approved blasting unit shall be identified as permissible by a legible and permanent marking securely attached, stamped, or molded to the outside of the unit. This marking shall include the following:

(a) The assigned MSHA approval number.

(b) The maximum blasting circuit resistance.

(c) A warning that the unit's components must not be disassembled or removed.

(d) The replacement battery types if the unit has replaceable batteries.

(e) A warning placed next to the charging connector that the battery only be charged in a fresh air location if rechargeable batteries are used.

(f) A warning that the unit is compatible only with detonators that will—

(1) Fire when an average of 1.5 amperes is applied for 5 milliseconds;

(2) Not misfire when up to an average 100 amperes is applied for 10 milliseconds; and

(3) Not fire when a current of 250 milliamperes or less is applied.

§ 7.70 Post-approval product audit.

Upon request by MSHA, but not more than once a year except for cause, the approval holder shall make an approved blasting unit available for audit at no cost to MSHA.

§ 7.71 Approval checklist.

Each blasting unit bearing an MSHA approval marking shall be accompanied by a description of what is necessary to maintain the blasting unit as approved.

[54 FR 48210, Nov. 21, 1989, as amended at 60 FR 33723, June 29, 1995]

§ 7.72 New technology.

MSHA may approve a blasting unit that incorporates technology for which the requirements of this subpart are not applicable if the Agency determines that the blasting unit is as safe as those which meet the requirements of this subpart.

Subpart E—Diesel Engines Intended for Use in Underground Coal Mines

SOURCE: 61 FR 55504, Oct. 25, 1996, unless otherwise noted.

§ 7.81 Purpose and effective date.

Subpart A general provisions of this part apply to this subpart E. Subpart E establishes the specific engine performance and exhaust emission requirements for MSHA approval of diesel engines for use in areas of underground coal mines where permissible electric equipment is required and areas where non-permissible electric equipment is allowed. It is effective November 25, 1996.

§ 7.82 Definitions.

In addition to subpart A definitions of this part, the following definitions apply in this subpart.

Brake Power. The observed power measured at the crankshaft or its equivalent when the engine is equipped only with standard auxiliaries necessary for its operation on the test bed.

Category A engines. Diesel engines intended for use in areas of underground coal mines where permissible electric equipment is required.

Category B engines. Diesel engines intended for use in areas of underground coal mines where nonpermissible electric equipment is allowed.

Corrosion-resistant material. Material that has at least the corrosion-resistant properties of type 304 stainless steel.

Diesel engine. Any compression ignition internal combustion engine using the basic diesel cycle where combustion results from the spraying of fuel into air heated by compression.

Exhaust emission. Any substance emitted to the atmosphere from the exhaust port of the combustion chamber of a diesel engine.

Intermediate speed. Maximum torque speed if it occurs between 60 percent and 75 percent of rated speed. If the maximum torque speed is less than 60 percent of rated speed, then the intermediate speed shall be 60 percent of the rated speed. If the maximum torque speed is greater than 75 percent of the rated speed, then the intermediate speed shall be 75 percent of rated speed.

Low idle speed. The minimum no load speed as specified by the engine manufacturer.

Maximum torque speed. The speed at which an engine develops maximum torque.

Operational range. All speed and load (including percent loads) combinations from the rated speed to the minimum permitted engine speed at full load as specified by the engine manufacturer.

Particulates. Any material collected on a specified filter medium after diluting exhaust gases with clean, filtered air at a temperature of less than or equal to 125 °F (52 °C), as measured at a point immediately upstream of the primary filter. This is primarily carbon, condensed hydrocarbons, sulfates, and associated water.

Percent load. The fraction of the maximum available torque at an engine speed.

Rated horsepower. The nominal brake power output of a diesel engine as specified by the engine manufacturer with a specified production tolerance. For laboratory test purposes, the fuel pump calibration for the rated horsepower must be set between the nominal and the maximum fuel tolerance specification.

Rated speed. Speed at which the rated power is delivered, as specified by the engine manufacturer.

Steady-state condition. Diesel engine operating condition which is at a constant speed and load and at stabilized temperatures and pressures.

Total oxides of nitrogen. The sum total of the measured parts per millions (ppm) of nitric oxide (NO) plus the measured ppm of nitrogen dioxide (NO_2).

§ 7.83 Application requirements.

(a) An application for approval of a diesel engine shall contain sufficient information to document compliance with the technical requirements of this subpart and specify whether the application is for a category A engine or category B engine.

(b) The application shall include the following engine specifications—

(1) Model number;

(2) Number of cylinders, cylinder bore diameter, piston stroke, engine displacement;

(3) Maximum recommended air inlet restriction and exhaust backpressure;

(4) Rated speed(s), rated horsepower(s) at rated speed(s), maximum torque speed, maximum rated torque, high idle, minimum permitted engine speed at full load, low idle;

(5) Fuel consumption at rated horsepower(s) and at the maximum rated torque;

(6) Fuel injection timing; and

(7) Performance specifications of turbocharger, if applicable.

(c) The application shall include dimensional drawings (including tolerances) of the following components specifying all details affecting the technical requirements of this subpart. Composite drawings specifying the required construction details may be submitted instead of individual drawings of the following components—

(1) Cylinder head;

(2) Piston;

(3) Inlet valve;

(4) Exhaust valve;

(5) Cam shaft—profile;

(6) Fuel cam shaft, if applicable;

(7) Injector body;

(8) Injector nozzle;

(9) Injection fuel pump;

(10) Governor;

(11) Turbocharger, if applicable;

(12) Aftercooler, if applicable;

(13) Valve guide;

(14) Cylinder head gasket; and

(15) Precombustion chamber, if applicable.

(d) The application shall include a drawing showing the general arrangement of the engine.

(e) All drawings shall be titled, dated, numbered, and include the latest revision number.

(f) When all necessary testing has been completed, the following information shall be submitted:

(1) The gaseous ventilation rate for the rated speed and horsepower.

(2) The particulate index for the rated speed and horsepower.

(3) A fuel deration chart for altitudes for each rated speed and horsepower.

§ 7.84 Technical requirements.

(a) *Fuel injection adjustment.* The fuel injection system of the engine shall be constructed so that the quantity of fuel injected can be controlled at a desired maximum value. This adjustment shall be changeable only after breaking a seal or by altering the design.

(b) *Maximum fuel-air ratio.* At the maximum fuel-air ratio determined by § 7.87 of this part, the concentrations (by volume, dry basis) of carbon monoxide (CO) and oxides of nitrogen (NO_X) in the undiluted exhaust gas shall not exceed the following:

(1) There shall be no more than 0.30 percent CO and no more than 0.20 percent NO_X for category A engines.

(2) There shall be no more than 0.25 percent CO and no more than 0.20 percent NO_X for category B engines.

(c) *Gaseous emissions ventilation rate.* Ventilation rates necessary to dilute gaseous exhaust emissions to the following values shall be determined under § 7.88 of this part:

Carbon dioxide	−5000 ppm
Carbon monoxide	−50 ppm
Nitric oxide	−25 ppm
Nitrogen dioxide	−5 ppm

A gaseous ventilation rate shall be determined for each requested speed and horsepower rating as described in § 7.88(b) of this part.

(d) *Fuel deration.* The fuel rates specified in the fuel deration chart shall be based on the tests conducted under paragraphs (b) and (c) of this section and shall ensure that the maximum fuel:air (f/a) ratio determined under paragraph (b) of this section is not exceeded at the altitudes specified in the fuel deration chart.

(e) *Particulate index.* For each rated speed and horsepower requested, the particulate index necessary to dilute the exhaust particulate emissions to 1 mg/m^3 shall be determined under § 7.89 of this part.

§ 7.85 Critical characteristics.

The following critical characteristics shall be inspected or tested on each diesel engine to which an approval marking is affixed—

(a) Fuel rate is set properly; and

(b) Fuel injection pump adjustment is sealed, if applicable.

§ 7.86 Test equipment and specifications.

(a) Dynamometer test cell shall be used in determining the maximum f/a ratio, gaseous ventilation rates, and the particulate index.

(1) The following testing devices shall be provided:

(i) An apparatus for measuring torque that provides an accuracy of ±2.0 percent based on the engine's maximum value;

(ii) An apparatus for measuring revolutions per minute (rpm) that provides an accuracy of ±2.0 percent based on the engine's maximum value;

(iii) An apparatus for measuring temperature that provides an accuracy of ±4 °F (2 °C) of the absolute value except for the exhaust gas temperature device that provides an accuracy of ±27 °F (15 °C);

(iv) An apparatus for measuring intake and exhaust restriction pressures that provides an accuracy of ±5 percent of maximum;

(v) An apparatus for measuring atmospheric pressure that provides an accuracy of ±0.5 percent of reading;

(vi) An apparatus for measuring fuel flow that provides an accuracy of ±2 percent based on the engine's maximum value;

(vii) An apparatus for measuring the inlet air flow rate of the diesel engine that provides an accuracy of ±2 percent based on the engine's maximum value; and

(viii) For testing category A engines, an apparatus for metering in 1.0 ±0.1

percent, by volume, of methane (CH_4) into the intake air system shall be provided.

(2) The test fuel specified in Table E–1 shall be a low volatile hydrocarbon fuel commercially designated as "Type 2–D" grade diesel fuel. The fuel may contain nonmetallic additives as follows: Cetane improver, metal deactivator, antioxidant, dehazer, antirust, pour depressant, dye, dispersant, and biocide.

TABLE E–1—DIESEL TEST FUEL SPECIFICATIONS

Item	ASTM	Type 2–D
Cetane number	D613	40–48.
Cetane index	D976	40–48.
Distillation range:		
IBP °F	D86	340–400.
(°C)		(171.1–204.4).
10 pct. point, °F	D86	400–460.
(°C)		(204.4–237.8).
50 pct. point, °F	D86	470.540.
(°C)		(243.3–282.2).
90 pct. point, °F	D86	560–630.
(°C)		(293.3–332.2).
EP, °F	D86	610–690.
(°C)		(321.1–365.6).
Gravity,°API	D287	32–37.
Total sulfur, pct.	D2622	0.03–0.05.
Hydrocarbon composition:		
Aromatics, pct.	D1319	27 minimum.
Paraffins, naphthenes, olefins.	D1319	Remainder.
Flashpoint, minimum, °F	93	130.
(°C)		(54.4).
Viscosity, centistokes	445	2.0–3.2.

(3) The test fuel temperature at the inlet to the diesel engine's fuel injection pump shall be controlled to the engine manufacturer's specification.

(4) The engine coolant temperature (if applicable) shall be maintained at normal operating temperatures as specified by the engine manufacturer.

(5) The charge air temperature and cooler pressure drop (if applicable) shall be set to within ±7 °F(4 °C) and ±0.59 inches Hg (2kPa) respectively, of the manufacturer's specification.

(b) Gaseous emission sampling system shall be used in determining the gaseous ventilation rates.

(1) The schematic of the gaseous sampling system shown in Figure E–1 shall be used for testing category A engines. Various configurations of Figure E–1 may produce equivalent results. The components in Figure E–1 are designated as follows—

(i) Filters—F1, F2, F3, and F4;

(ii) Flowmeters—FL1, FL2, FL3, FL4, FL5, FL6, and FL7;

(iii) Upstream Gauges—G1, G2, and G5;

(iv) Downstream Gauges—G3, G4, and G6;

(v) Pressure Gauges—P1, P2, P3, P4, P5, and P6;

(vi) Regulators—R1, R2, R3, R4, R5, R6, and R7;

(vii) Selector Valves—V1, V2, V3, V4, V6, V7, V8, V15, and V19;

(viii) Heated Selector Valves—V5, V13, V16, and V17;

(ix) Flow Control Valves—V9, V10, V11 and V12;

(x) Heated Flow Control Valves—V14 and V18;

(xi) Pump—Sample Transfer Pump;

(xii) Temperature Sensor—(T1);

(xiii) Dryer—D1 and D2; and

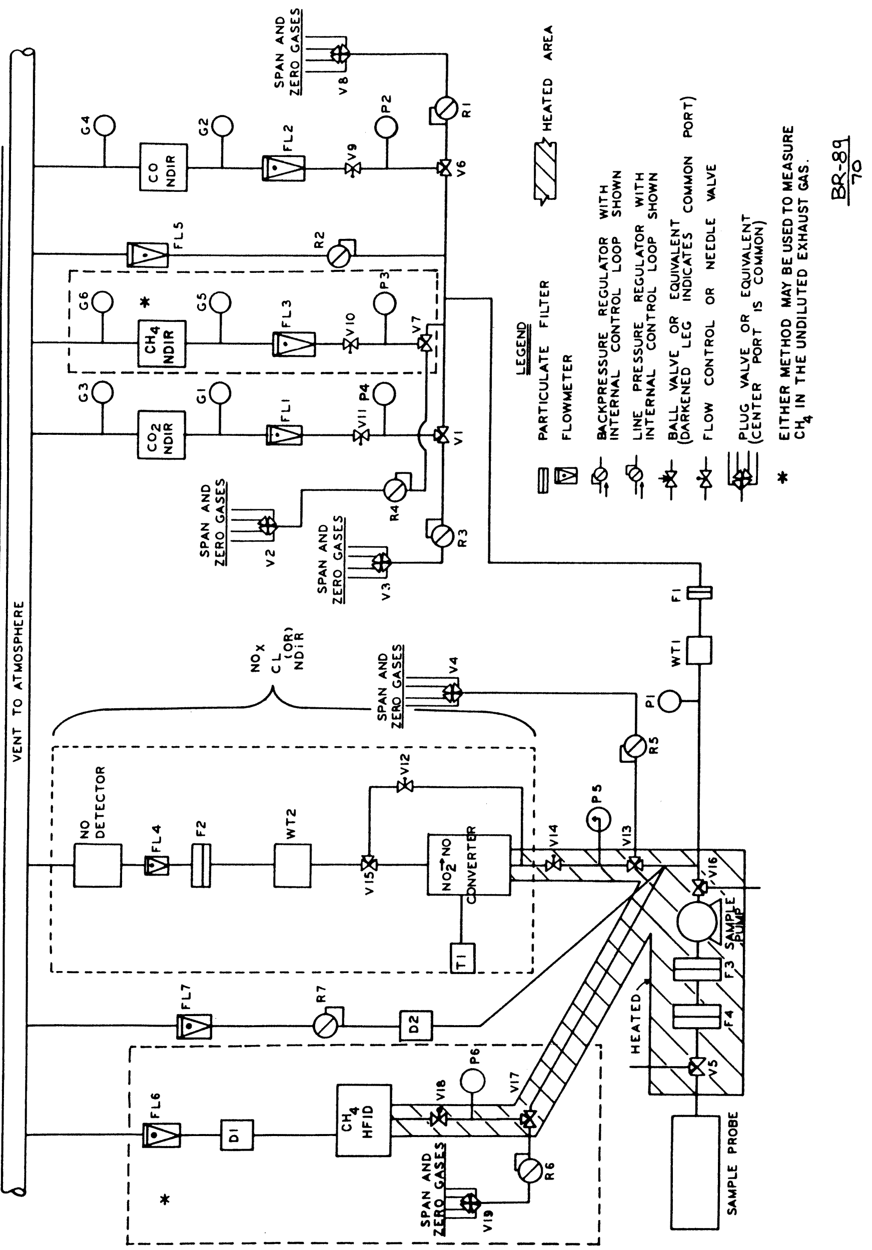
(xiv) Water traps—WT1 and WT2.

(A) Water removal from the sample shall be done by condensation.

(B) The sample gas temperature or dew point shall be monitored either within the water trap or downstream of the water trap and shall not exceed 45 °F (7 °C).

(C) Chemical dryers are not permitted.

FIG. E-1 EXHAUST GAS SAMPLING AND ANALYTICAL TRAIN —CATAGORY A ENGINES



(2) The schematic of the gaseous sampling system shown in Figure E–2 shall be used for testing category B engines. Various configurations of Figure E–2 may produce equivalent results. The components are designated as follows—

(i) Filters—F1, F2, F3, and F4;

(ii) Flowmeters—FL1, FL2, FL3, and FL4;

(iii) Upstream Gauges—G1, and G2;

(iv) Downstream Gauges—G3, and G4;

(v) Pressure Gauges—P1, P2, P3, and P4;

(vi) Regulators—R1, R2, R3, and R4;

(vii) Selector Valves—V1, V2, V3, V4, V6, and V7;

(viii) Heated Selector Valves—V5, V8, and V12;

(ix) Flow Control Valves—V9, V10, V11;

(x) Heated Flow Control Valves—V13;

(xi) Pump—Sample Transfer Pump;

(xii) Temperature Sensor—(T1); and

(xiii) Water traps—WT1 and WT2.

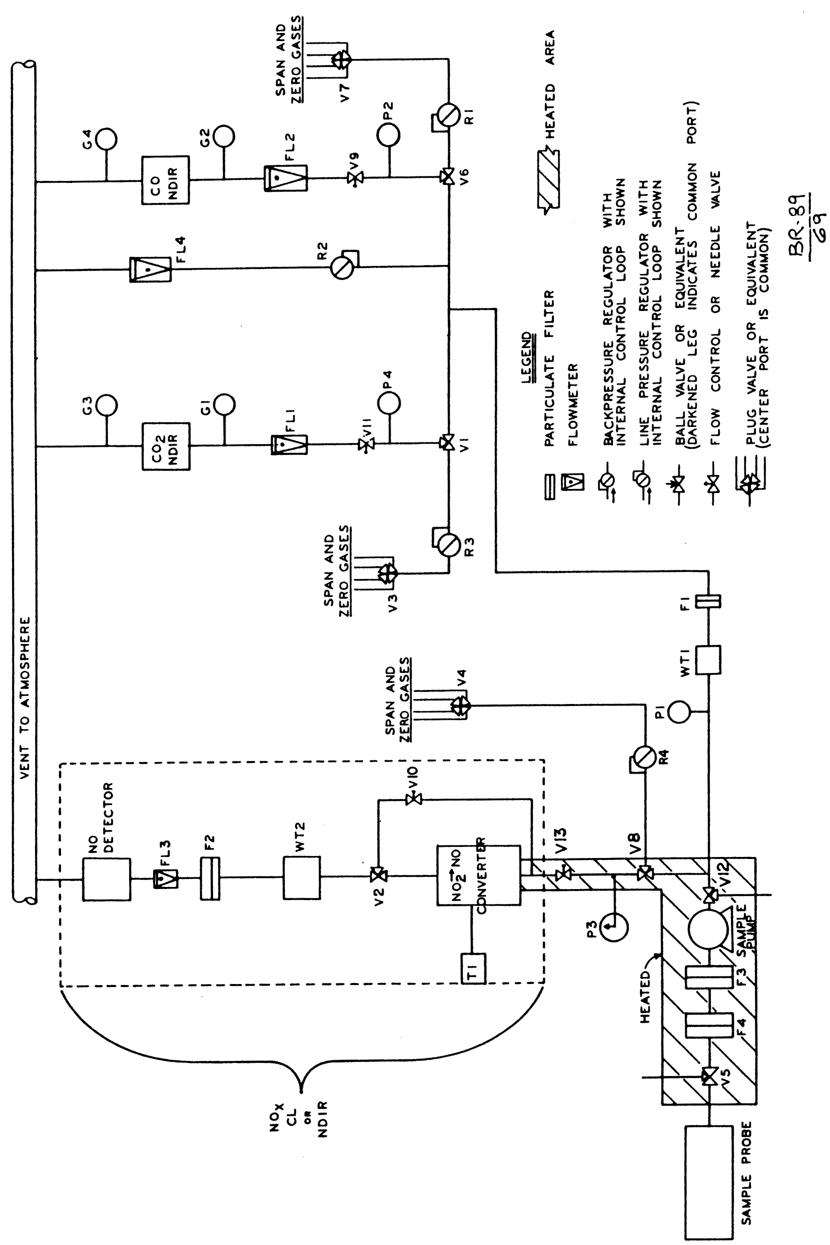
(A) Water removal from the sample shall be done by condensation.

(B) The sample gas temperature or dew point shall be monitored either within the water trap or downstream of the water trap and shall not exceed 45 °F (7 °C).

(C) Chemical dryers are not permitted.

(3) All components or parts of components that are in contact with the sample gas or corrosive calibration gases shall be corrosion-resistant material.

FIG. E-2 EXHAUST GAS SAMPLING AND ANALYTICAL TRAIN·CATAGORY B ENGINES



(4) All analyzers shall obtain the sample to be analyzed from the same sample probe.

(5) CO and CO_2 measurements shall be made on a dry basis.

(6) Calibration or span gases for the NO_X measurement system shall pass through the NO_2 to NO converter.

(7) A stainless steel sample probe shall be straight, closed-end, multi-holed, and shall be placed inside the exhaust pipe.

(i) The probe length shall be at least 80 percent of the diameter of the exhaust pipe.

(ii) The inside diameter of the sample probe shall not be greater than the inside diameter of the sample line.

(iii) The heated sample line shall have a 0.197 inch (5 mm) minimum and a 0.53 inch (13.5 mm) maximum inside diameter.

(iv) The wall thickness of the probe shall not be greater than 0.040 inch (1 mm).

(v) There shall be a minimum of 3 holes in 3 different radial planes sized to sample approximately the same flow.

(8) The sample probe shall be located in the exhaust pipe at a minimum distance of 1.6 feet (0.5 meters) or 3 times the diameter of the exhaust pipe, whichever is the larger, from the exhaust manifold outlet flange or the outlet of the turbocharger. The exhaust gas temperature at the sample probe shall be a minimum of 158 °F (70 °C).

(9) The maximum allowable leakage rate on the vacuum side of the analyzer pump shall be 0.5 percent of the in-use flow rate for the portion of the system being checked.

(10) *General analyzer specifications.* (i) The total measurement error, including the cross sensitivity to other gases, (paragraphs (b)(11)(ii), (b)(12)(iii), (b)(13)(iii), and (b)(13)(iv) of this section), shall not exceed ±5 percent of the reading or ±3.5 percent of full scale, whichever is smaller. For concentrations of less than 100 ppm the measurement error shall not exceed ±4 ppm.

(ii) The repeatability, defined as 2.5 times the standard deviation of 10 repetitive responses to a given calibration or span gas, must be no greater than ±1 percent of full scale concentration for each range used above 155 parts per million (ppm) or parts per million equivalent carbon (ppmC) or ±2 percent of each range used below 155 ppm (or ppmC).

(iii) The analyzer peak to peak response to zero and calibration or span gases over any 10 second period shall not exceed 2 percent of full scale on all ranges used.

(iv) The analyzer zero drift during a 1-hour period shall be less than 2 percent of full scale on the lowest range used. The zero-response is the mean response, including noise, to a zero gas during a 30-second time interval.

(v) The analyzer span drift during a 1-hour period shall be less than 2 percent of full scale on the lowest range used. The analyzer span is defined as the difference between the span response and the zero response. The span response is the mean response, including noise, to a span gas during a 30-second time interval.

(11) *CO and CO_2 analyzer specifications.* (i) Measurements shall be made with nondispersive infrared (NDIR) analyzers.

(ii) For the CO analyzer, the water and CO_2 interference shall be less than 1 percent of full scale for ranges equal to or greater than 300 ppm (3 ppm for ranges below 300 ppm) when a CO_2 span gas concentration of 80 percent to 100 percent of full scale of the maximum operating range used during testing is bubbled through water at room temperature.

(12) For NO_X analysis using a chemiluminescence (CL) analyzer the following parameters shall apply:

(i) From the sample point to the NO_2 to NO converter, the NO_X sample shall be maintained between 131 °F (55 °C) and 392 °F (200 °C).

(ii) The NO_2 to NO converter efficiency shall be at least 90 percent.

(iii) The quench interference from CO_2 and water vapor must be less than 3.0 percent.

(13) For NO_X analysis using an NDIR analyzer system the following parameters shall apply:

(i) The system shall include a NO_2 to NO converter, a water trap, and a NDIR analyzer.

(ii) From the sample point to the NO_2 to NO converter, the NO_X sample shall be maintained between 131 °F (55 °C) and 392 °F (200 °C).

(iii) The minimum water rejection ratio (maximum water interference) for the NO_X NDIR analyzer shall be 5,000:1.

(iv) The minimum CO_2 rejection ratio (maximum CO_2 interference) for the NO_X NDIR analyzer shall be 30,000:1.

(14) When CH_4 is measured using a heated flame ionization detector (HFID) the following shall apply:

(i) The analyzer shall be equipped with a constant temperature oven that houses the detector and sample-handling components.

(ii) The detector, oven, and sample-handling components shall be suitable for continuous operation at temperatures of 374 °F (190 °C) ±18 °F (10 °C).

(iii) The analyzer fuel shall contain 40 ±2 percent hydrogen. The balance shall be helium. The mixture shall contain ≤ 1 part per million equivalent carbon (ppmC), and ≤ 400 ppm CO.

(iv) The burner air shall contain < 2 ppmC hydrocarbon.

(v) The percent of oxygen interference shall be less than 5 percent.

(15) An NDIR analyzer for measuring CH_4 may be used in place of the HFID specified in paragraph (b)(14) of this section and shall conform to the requirements of paragraph (b)(10) of this section. Methane measurements shall be made on a dry basis.

(16) Calibration gas values shall be traceable to the National Institute for Standards and Testing (NIST), ''Standard Reference Materials'' (SRM's). The analytical accuracy of the calibration gas values shall be within 2.0 percent of NIST gas standards.

(17) Span gas values shall be traceable to NIST SRM's. The analytical accuracy of the span gas values shall be within 2.0 percent of NIST gas standards.

(18) Calibration or span gases for the CO and CO_2 analyzers shall have purified nitrogen as a diluent. Calibration or span gases for the CH_4 analyzer shall be CH_4 with purified synthetic air or purified nitrogen as diluent.

(19) Calibration or span gases for the NO_X analyzer shall be NO with a maximum NO_2 concentration of 5 percent of the NO content. Purified nitrogen shall be the diluent.

(20) Zero-grade gases for the CO, CO_2, CH_4 , and NO_X analyzers shall be either purified synthetic air or purified nitrogen.

(21) The allowable zero-grade gas (purified synthetic air or purified nitrogen) impurity concentrations shall not exceed ≤ 1ppm C, ≤ 1 ppm CO, ≤ 400 ppm CO_2, and ≤ 0.1 ppm NO.

(22) The calibration and span gases may also be obtained by means of a gas divider. The accuracy of the mixing device must be such that the concentration of the diluted calibration gases are within 2 percent.

(c) Particulate sampling system shall be used in determining the particulate index. A schematic of a full flow (single dilution) particulate sampling system for testing under this subpart is shown in Figures E–3 and E–4.

(1) The dilution system shall meet the following parameters:

(i) Either a positive displacement pump (PDP) or a critical flow venturi (CFV) shall be used as the pump/mass measurement device shown in Figure E–3.

(ii) The total volume of the mixture of exhaust and dilution air shall be measured.

(iii) All parts of the system from the exhaust pipe up to the filter holder, which are in contact with raw and diluted exhaust gas, shall be designed to minimize deposition or alteration of the particulate.

(iv) All parts shall be made of electrically conductive materials that do not react with exhaust gas components.

(v) All parts shall be electrically grounded to prevent electrostatic effects.

(vi) Systems other than full flow systems may also be used provided they yield equivalent results where:

(A) A seven sample pair (or larger) correlation study between the system under consideration and a full flow dilution system shall be run concurrently.

(B) Correlation testing is to be performed at the same laboratory, test cell, and on the same engine.

(C) The equivalency criterion is defined as a ±5 percent agreement of the sample pair averages.

(2) The mass of particulate in the exhaust shall be collected by filtration. The exhaust temperature immediately

before the primary particulate filter shall not exceed 125 °F (52.0 °C).

(3) Exhaust system backpressure shall not be artificially lowered by the PDP, CFV systems or dilution air inlet system. Static exhaust backpressure measured with the PDP or CFV system operating shall remain within ±0.44 inches Hg (1.5 kPa) of the static pressure measured without being connected to the PDP or CFV at identical engine speed and load.

(4) The gas mixture temperature shall be measured at a point immediately ahead of the pump or mass measurement device.

(i) Using PDP, the gas mixture temperature shall be maintained within ±10 °F (6.0 °C) of the average operating temperature observed during the test, when no flow compensation is used.

(ii) Flow compensation can be used provided that the temperature at the inlet to the PDP does not exceed 122 °F (50 °C).

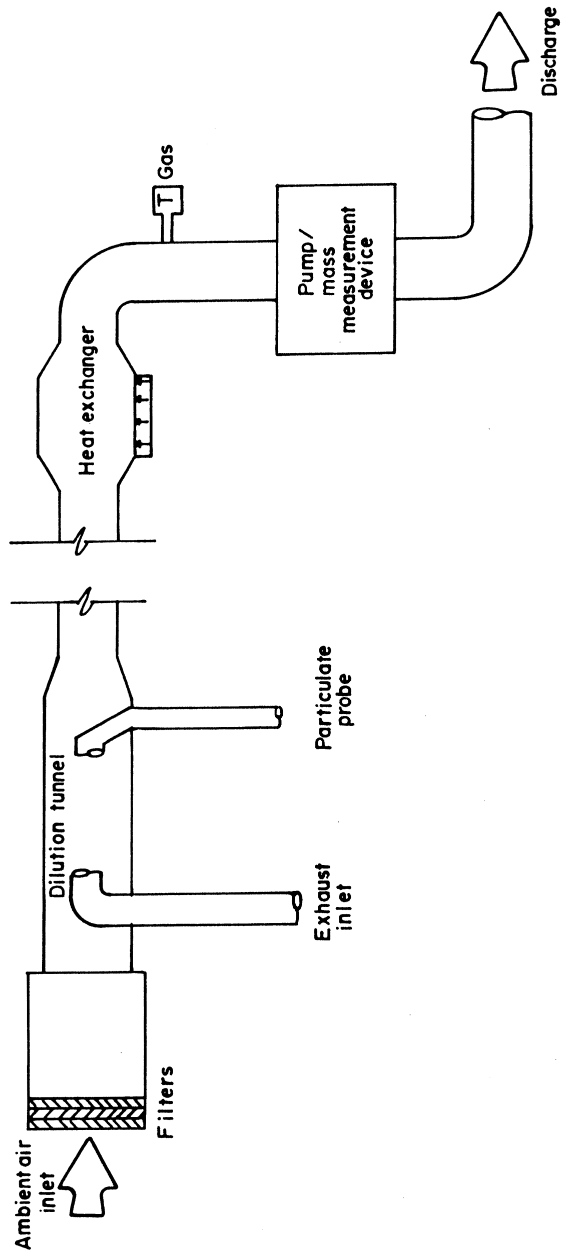
(iii) Using CFV, the gas mixture temperature shall be maintained within ±20 °F (11 °C) of the average operating temperature observed during the test, when no flow compensation is used.

(5) The heat exchanger shall be of sufficient capacity to maintain the temperature within the limits required above and is optional if electronic flow compensation is used.

(6) When the temperature at the inlet of either the PDP or CFV exceeds the limits stated in either paragraphs (c)(4)(i) or (c)(4)(iii) of this section, an electronic flow compensation system shall be required for continuous measurement of the flow rate and control of the proportional sampling in the particulate sampling system.

(7) The flow capacity of the system shall be large enough to eliminate water condensation.

FIG. E-3 DILUTION TUNNEL/CONSTANT VOLUME SYSTEM



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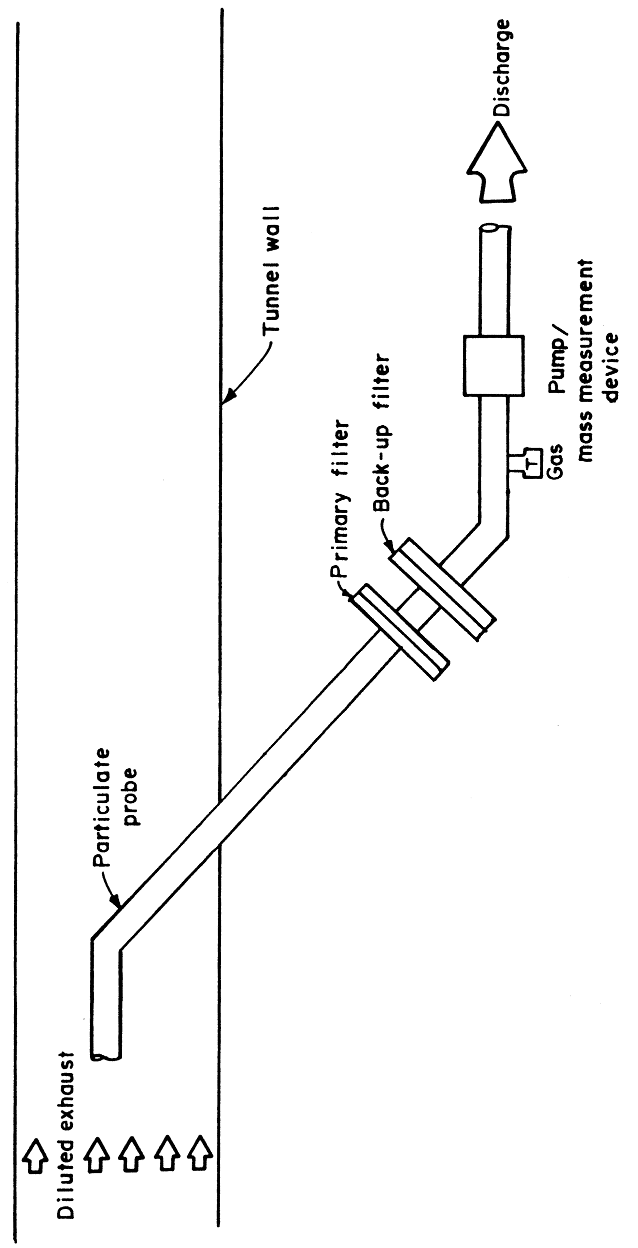

FIG. E-4 PARTICULATE SAMPLING SYSTEM

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(8) The flow capacity of the PDP or CFV system using single dilution shall maintain the diluted exhaust at 125 °F (52.0 °C) or less immediately before the primary particulate filter.

(9) The flow capacity of the PDP or CFV system using a double dilution

system shall be sufficient to maintain the diluted exhaust in the dilution tunnel at 375 °F (191 °C) or less at the sampling zone.

(10) The secondary dilution system shall provide sufficient secondary dilution air to maintain the double-diluted exhaust stream at 125 °F (52.0 °C) or less immediately before the primary particulate filter.

(11) The gas flow meters or the mass flow measurement instrumentation shall have a maximum error of the measured value within ±2 percent of reading.

(12) The dilution air shall have a temperature of 77 °F ±9 °F (25 °C ±5 °C), and be—

(i) Filtered at the air inlet; or

(ii) Sampled to determine background particulate levels, which can then be subtracted from the values measured in the exhaust stream.

(13) The dilution tunnel shall have the following specifications:

(i) Be small enough in diameter to cause turbulent flow (Reynolds number greater than 4,000) and of sufficient length to cause complete mixing of the exhaust and dilution air;

(ii) Be at least 3 inches (75 mm) in diameter; and

(iii) Be configured to direct the engine exhaust downstream at the point where it is introduced into the dilution tunnel for thorough mixing.

(14) The exhaust pipe length from the exit of the engine exhaust manifold or turbocharger outlet to the dilution tunnel shall not exceed a total length of 32 feet (10 m).

(i) When the exhaust pipe exceeds 12 feet (4 m), then all pipe in excess of 12 feet (4 m) shall be insulated with a radial thickness of at least 1.0 inch (25 mm) and the thermal conductivity of the insulating material shall be no greater than 0.1 W/mK measured at 752 °F (400 °C).

(ii) To reduce the thermal inertia of the exhaust pipe, the thickness to diameter ratio shall be 0.015 or less.

(iii) The use of flexible sections shall be limited to the length to diameter ratio of 12 or less.

(15) The particulate sample probe shall—

(i) Be installed in the dilution tunnel facing upstream, on the dilution tunnel centerline, and approximately 10 dilution tunnel diameters downstream of the point where the engine's exhaust enters the dilution tunnel; and

(ii) Have 0.5 inches (12 mm) minimum inside diameter.

(16) The inlet gas temperature to the particulate sample pump or mass measurement device shall remain a constant temperature of ±5 °F (3.0 °C) if flow compensation is not used.

(17) The secondary dilution portion of the double dilution system shall have:

(i) A particulate transfer tube shall have a 0.5 inch (12 mm) minimum inside diameter not to exceed 40 inches (1020 mm) in length measured from the probe tip to the secondary dilution tunnel has:

(A) An inlet with the transfer tube facing upstream in the primary dilution tunnel, centerline, and approximately 10 dilution tunnel diameters downstream of the point where the engine's exhaust enters the dilution tunnel.

(B) An outlet where the transfer tube exits on the centerline of the secondary tunnel and points downstream.

(ii) A secondary tunnel that has a minimum diameter of 3.0 inches (75 mm), and of sufficient length to provide a residence time of at least 0.25 seconds for the double-diluted sample.

(iii) Secondary dilution air supplied at a temperature of 77 °F ±9 °F (25 °C ±5 °C).

(iv) A primary filter holder located within 12.0 inches (300 mm) of the exit of the secondary tunnel.

(18) The particulate sampling filters shall—

(i) Be fluorocarbon-coated glass fiber filters or fluorocarbon-based (membrane) filters and have a 0.3 μm dioctylphthalate (DOP) collection efficiency of at least 95 percent at a gas face velocity between 35 and 80 cm/s.;

(ii) Have a minimum diameter of 1.85 inches (47 mm), 1.46 inches (37 mm) stain diameter;

(iii) Have a minimum filter loading ratio of 0.5mg/1075 mm^2 stain area for the single filter method.

(iv) Have minimum filter loading such that the sum of all eight (8) multiple filters is equal to the minimum loading value (mg) for a single filter multiplied by the square root of eight (8).

(v) Be sampled at the same time by a pair of filters in series (one primary and one backup filter) so that:

(A) The backup filter holder shall be located no more than 4 inches (100 mm) downstream of the primary filter holder.

(B) The primary and backup filters shall not be in contact with each other.

(C) The filters may be weighed separately or as a pair with the filters placed stain side to stain side.

(D) The single filter method incorporates a bypass system for passing the sample through the filters at the desired time.

(vi) Have a pressure drop increase between the beginning and end of the test of no more than 7.4 in Hg (25kPa).

(vii) Filters of identical quality shall be used when performing correlation tests specified in paragraph (c)(1)(vi) of this section.

(19) *Weighing chamber specifications.* (i) The temperature of the chamber (room) in which the particulate filters are conditioned and weighed shall be maintained to within 72 °F ±5 °F (22 °C ±3 °C) during all filter conditioning and weighing.

(ii) The humidity of the chamber (room) in which the particulate filters are conditioned and weighed shall be maintained to a dewpoint of 49 °F ±5 °F (9.5 °C ±3 °C) and a relative humidity of 45 percent ±8 percent during all filter conditioning and weighing.

(iii) The chamber (room) environment shall be free of any ambient contaminants (such as dust) that would settle on the particulate filters during their stabilization. This shall be determined as follows:

(A) At least two unused reference filters or reference filter pairs shall be weighed within four (4) hours of, but preferably at the same time as the sample filter (pair) weighings.

(B) The reference filters are to be the same size and material as the sample filters.

(C) If the average weight of reference filters (reference filter pairs) changes between sample filter weighings by more than ±5.0 percent (±7.5 percent for the filter pair respectively) of the recommended minimum filter loading in paragraphs (c)(18)(iii) or (c)(18)(iv) of this section, then all sample filters shall be discarded and the tests repeated.

(20) The analytical balance used to determine the weights of all filters shall have a precision (standard deviation) of 20 µg and resolution of 10 µg. For filters less than 70 mm diameter, the precision and resolution shall be 2 µg and 1 µg, respectively.

(21) All filters shall be neutralized to eliminate the effects of static electricity prior to weighing.

§ 7.87 Test to determine the maximum fuel-air ratio.

(a) *Test procedure.* (1) Couple the diesel engine to the dynamometer and connect the sampling and measurement devices specified in § 7.86.

(2) Prior to testing, zero and span the CO and NO_X analyzers to the lowest analyzer range that will be used during this test.

(3) While running the engine, the following shall apply:

(i) The parameter for the laboratory atmospheric factor, f_a, shall be: $0.98 \leq f_a \leq 1.02$;

(A) The equation is $f_a=(99/P_s) * ((T_a+273)/298)^{0.7}$ for a naturally aspirated and mechanically supercharged engines; or

(B) The equation is $f_a=(99/P_s)^{0.7} * ((T_a+273)/298)^{1.5}$ for a turbocharged engine with or without cooling of the intake air.

Where:

P_s = dry atmospheric pressure (kPa)
T_a = intake air temperature (°C)

(ii) The air inlet restriction shall be set within ±10 percent of the recommended maximum air inlet restriction as specified by the engine manufacturer at the engine operating condition giving maximum air flow to determine the concentration of CO as specified in paragraph (a)(6) of this section.

(iii) The exhaust backpressure restriction shall be set within ±10 percent of the maximum exhaust backpressure as specified by the engine manufacturer at the engine operating condition giving maximum rated horsepower to determine the concentrations of CO and NO_X as specified in paragraph (a)(6)of this section.

(iv) The air inlet restriction shall be set within ±10 percent of a recommended clean air filter at the engine operating condition giving maximum air flow as specified by the engine manufacturer to determine the concentration of NO_X as specified in paragraph (a)(6) of this section.

(4) The engine shall be at a steady-state condition when the exhaust gas samples are collected and other test data is measured.

(5) In a category A engine, 1.0 ±0.1 percent CH_4 shall be injected into the engine's intake air.

(6) Operate the engine at several speed/torque conditions to determine the concentrations of CO and NO_X, dry basis, in the raw exhaust.

(b) *Acceptable performance.* The CO and NO_X concentrations in the raw exhaust shall not exceed the limits specified in § 7.84(b) throughout the specified operational range of the engine.

§ 7.88 Test to determine the gaseous ventilation rate.

The test shall be performed in the order listed in Table E–2. The test for determination of the particulate index described in § 7.89 may be done simultaneously with this test.

(a) *Test procedure.* (1) Couple the diesel engine to the dynamometer and attach the sampling and measurement devices specified in § 7.86.

(2) A minimum time of 10 minutes is required for each test mode.

(3) CO, CO_2, NO_X, and CH_4 analyzers shall be zeroed and spanned at the analyzer range to be used prior to testing.

(4) Run the engine.

(i) The parameter for f_a shall be calculated in accordance with § 7.87(a)(3).

(ii) The air inlet and exhaust backpressure restrictions on the engine shall be set as specified in §§ 7.87(a)(3) (iii) and (iv).

(5) The engine shall be at a steady-state condition before starting the test modes.

(i) The output from the gas analyzers shall be measured and recorded with exhaust gas flowing through the analyzers a minimum of the last three (3) minutes of each mode.

(ii) To evaluate the gaseous emissions, the last 60 seconds of each mode shall be averaged.

(iii) A 1.0 ±0.1 percent CH_4, by volume, shall be injected into the engine's intake air for category A engines.

(iv) The engine speed and torque shall be measured and recorded at each test mode.

(v) The data required for use in the gaseous ventilation calculations specified in paragraph (a)(9) of this section shall be measured and recorded at each test mode.

(6) Operate the engine at each rated speed and horsepower rating requested by the applicant according to Table E–2 in order to measure the raw exhaust gas concentration, dry basis, of CO, CO_2, NO, and NO_2, and CH_4- exhaust (category A engines only).

(i) Test speeds shall be maintained within ±1 percent of rated speed or ±3 RPM, which ever is greater, except for low idle which shall be within the tolerances established by the manufacturer.

(ii) The specified torque shall be held so that the average over the period during which the measurements are taken is within ±2 percent of the maximum torque at the test speed.

(7) The concentration of CH_4 in the intake air shall be measured for category A engines.

TABLE E–2—GASEOUS TEST MODES

Speed	Rated speed				Intermediate speed			Low-idle speed
% Torque	100	75	50	10	100	75	50	0

(8) After completion of the test modes, the following shall be done:

(i) Zero and span the analyzers at the ranges used during the test.

(ii) The gaseous emission test shall be acceptable if the difference in the zero and span results taken before the test and after the test are less than 2 percent.

(9) The gaseous ventilation rate for each exhaust gas contaminant shall be calculated as follows—

(i) The following abbreviations shall apply to both category A and category B engine calculations as appropriate:

cfm—Cubic feet per min (ft^3/min)
Exh—Exhaust
A—Air (lbs/hr)
H—Grains of water per lb. of dry intake air
J—Conversion factor
m—Mass flow rate (mass/hr)
TI—Intake air temperature (°F)
PCAir—Percent Air
$PCCH_4$—Percent CH_4 (intake air)
UCH_4—Unburned CH_4
$PCECH_4$—Percent Exhaust CH_4

(ii) Exhaust gas flow calculation for category B engines shall be (m Exh)=(A)+(m fuel).

(iii) Fuel/air ratio for category B engines shall be (f/a)=(m fuel) / (A).

(iv) Methane flow through category A engines shall be determined by the following:

$PCAir=100-PCCH_4$
$Y=(PCAir)(0.289)+(PCCH_4)(0.16)$
$Z=(0.16)(PCCH_4)\div Y$
$mCH_4=(A)(Z)\div(1-Z)$

(v) Exhaust gas flow calculation for category A engines shall be (m Exh)=(A)+(m fuel)+(m CH_4)

(vi) Unburned CH_4 (lbs/hr) calculation for category A engines shall be $mUCH_4$=(m Exh)(0.0052)($PCECH_4$)

(vii) Fuel/air ratio for category A engines shall be (f/a)=((m fuel)+(m CH_4)−(m UCH_4))÷(A)

(viii) Conversion from dry to wet basis for both category A and category B engines shall be:

(NO wet basis)=(NO dry basis)(J)
(NO_2 wet basis)=(NO_2 dry basis)(J)
(CO_2 wet basis)=(CO_2 dry basis)(J)
(CO wet basis)=(CO dry basis)(10^{-4})(J)

Where:

J=(f/a)(−1.87)+(1−(0.00022)(H))

(ix) NO and NO_2 correction for humidity and temperature for category A and category B engines shall be:

(NO corr)=(NO wet basis)÷(E)
(NO_2 corr)=(NO_2 wet basis)÷(E)

Where:

E=1.0+(R)(H−75)+(G)(TI−77)
R=(f/a)(0.044)−(0.0038)
G=(f/a)(−0.116)+(0.0053)

(x) The calculations to determine the m of each exhaust gas contaminant in grams per hour at each test point shall be as follows for category A and category B engines:

(m NO)=(NO corr)(0.000470)(m Exh)
(m NO_2)=(NO_2 corr)(0.000720)(m Exh)
(m CO_2)=(CO_2 wet basis)(6.89)(m Exh)
(m CO)=(CO wet basis)(4.38)(m Exh)

(xi) The calculations to determine the ventilation rate for each exhaust gas contaminant at each test point shall be as follows for category A and category B engines:

(cfm NO)=(m NO)(K)
(cfm NO_2)=(m NO_2)(K)
(cfm CO_2)=(m CO_2)(K)
(cfm CO)=(m CO)(K)

Where:

K=13,913.4/ (pollutant grams/mole) (pollutant dilution value specified in § 7.84(c)).

(b) The gaseous ventilation rate for each requested rated speed and horsepower shall be the highest ventilation rate calculated in paragraph (a)(9)(xi) of this section.

(1) Ventilation rates less than 20,000 cfm shall be rounded up to the next 500 cfm.

Example: 10,432 cfm shall be listed 10,500 cfm.

(2) Ventilation rates greater than 20,000 cfm shall be rounded up to the next 1,000 cfm.

Example: 26,382 cfm shall be listed 27,000 cfm.

[61 FR 55504, Oct. 25, 1996; 62 FR 34640, June 27, 1997]

§ 7.89 Test to determine the particulate index.

The test shall be performed in the order listed in Table E–3.

(a) *Test procedure.* (1) Couple the diesel engine to the dynamometer and connect the sampling and measurement devices specified in § 7.86.

(2) A minimum time of 10 minutes is required for each measuring point.

(3) Prior to testing, condition and weigh the particulate filters as follows:

(i) At least 1 hour before the test, each filter (pair) shall be placed in a closed, but unsealed, petri dish and placed in a weighing chamber (room) for stabilization.

(ii) At the end of the stabilization period, each filter (pair) shall be weighed. The reading is the tare weight.

(iii) The filter (pair) shall then be stored in a closed petri dish or a filter holder, both of which shall remain in the weighing chamber (room) until needed for testing.

(iv) The filter (pair) must be reweighed if not used within 8 hours of its removal from the weighing chamber (room).

(4) Run the engine.

(i) The parameter for f_a shall be calculated in accordance with § 7.87(a)(3).

(ii) The air inlet and exhaust backpressure restrictions on the engine shall be set as specified in §§ 7.87(a)(3) (iii) and (iv).

(iii) The dilution air shall be set to obtain a maximum filter face temperature of 125 °F (52 °C) or less at each test mode.

(iv) The total dilution ratio shall not be less than 4.

(5) The engine shall be at a steady state condition before starting the test modes.

(i) The engine speed and torque shall be measured and recorded at each test mode.

(ii) The data required for use in the particulate index calculation specified in paragraph (a)(9) of this section shall be measured and recorded at each test mode.

(6) A 1.0 ±0.1 percent CH_4, by volume shall be injected into the engine's intake air for category A engines.

(7) Operate the engine at each rated speed and horsepower rating requested by the applicant according to Table E–3 to collect particulate on the primary filter.

(i) One pair of single filters shall be collected or eight multiple filter pairs shall be collected.

(ii) Particulate sampling shall be started after the engine has reached a steady-state condition.

(iii) The sampling time required per mode shall be either a minimum of 20 seconds for the single filter method or a minimum of 60 seconds for the multiple filter method.

(iv) The minimum particulate loading specified in §§ 7.86(c)(18) (iii) or (iv) shall be done.

TABLE E–3—PARTICULATE TEST MODES

Speed	Rated speed				Intermediate speed			Low-idle speed
% Torque	100	75	50	10	100	75	50	0
Weighting factor	0.15	0.15	0.15	0.1	0.1	0.1	0.1	0.15

(v) Test speeds shall be maintained within ± percent of rated speed or ±3 RPM, which ever is greater, except for low idle which shall be within the tolerances set by the manufacturer.

(vi) The specified torque shall be held so that the average over the period during which the measurements are being taken is within ±2 percent of the maximum torque at the test speed.

(vii) The modal weighting factors (WF) given in Table E–3 shall be applied to the multiple filter method during the calculations as shown in paragraph (a)(9)(iii)(B) of this section.

(viii) For the single filter method, the modal WF shall be taken into account during sampling by taking a sample proportional to the exhaust mass flow for each mode of the cycle.

(8) After completion of the test, condition and weigh the particulate filters in the weighing chamber (room) as follows:

(i) Condition the filters for at least 1 hour, but not more than 80 hours.

(ii) At the end of the stabilization period, weigh each filter. The reading is the gross weight.

(iii) The particulate mass of each filter is its gross weight minus its tare weight.

(iv) The particulate mass (P_F for the single filter method; $P_{F,i}$ for the multiple filter method) is the sum of the particulate masses collected on the primary and back-up filters.

(v) The test is void and must be rerun if the sample on the filter contacts the petri dish or any other surface.

(9) The particulate index for the mass particulate shall be calculated from the equations listed below—

(i) The following abbreviations shall be:

cfm—Cubic feet per min (ft^3 min)
PT—Particulate (gr/hr)
m mix—Diluted exhaust gas mass flow rate on wet basis (kg/hr)
m sample—Mass of the diluted exhaust sample passed through the particulate sampling filters (kg)
P_f—Particulate sample mass collected on a filter (mg) at each test mode as determined in Table E–3.
K_p—Humidity correction factor for particulate
WF—Weighting factor
i-Subscript denoting an individual mode, i=1, . . . n
PI—Particulate Index (cfm)

(ii) When calculating ambient humidity correction for the particulate concentration (P_f part), the equation shall be:

$P_{fcorr}=(P_f)(K_p)$
$K_p=1/(1+0.0133*(H-10.71))$

Where:

H_a=humidity of the intake air, g water per kg dry air
$H_a=(6.220*R_a*p_a)/(p_B-p_a-R_a*10^{-2})$
R_a=relative humidity of the intake air, %
p_a=saturation vapor pressure of the intake air, kPa
p_B=total barometric pressure, kPa

(iii) When the multiple filter method is used, the following equations shall be used.

(A) Mass of particulate emitted is calculated as follows:

$$\text{PT gr/hr}_i = \frac{(P_{fcorr}\,\text{mg}_i)(\text{m mix kg/hr}_i)}{(\text{m sample kg}_i)(1000\text{ mg/gr})}$$

(B) Determination of weighted particulate average is calculated as follows:

$$\text{PT gr/hr} = \sum_{i=1}^{i=n}(\text{PT gr/hr}_i)(\text{WF}_i)$$

(C) Determination of particulate index for the mass particulate from the average of the test modes shall be calculated as follows:

$$\text{PI} = \frac{(\text{PT gr/hr})(1000\text{ mg/gr})(1\text{ hr}/60\text{ min})(35.31\text{ ft}^3/\text{m}^3)}{(1/1\text{ mg/m}^3)}$$

(iv) When the single filter method is used, the following equations shall be used.

(A) Mass of particulate emitted:

$$\text{PT gr/hr} = \frac{(P_{fcorr}\text{ mg})(\text{m mix kg/hr})\text{avg.}}{(\text{m sample kg})(1000\text{ mg/gr})}$$

Where:

$$(\text{m mix kg / hr})\,\text{avg.} = \sum_{i=1}^{i=n} (\text{m mix kg / hr}_i)(\text{WF}_i)$$

$$(\text{m sample kg}) = \sum_{i=1}^{i=n} (\text{m sample kg}_i)$$

(B) Determination of particulate index for the mass particulate from the average of the test modes shall be as follows:

$$\text{PI} = \frac{(\text{PT gr /hr})(1000\ \text{mg /gr})(1\ \text{hr /60 min})(35.31\ \text{ft}^3\ /\text{m}^3)}{(1 / 1\ \text{mg /m}^3)}$$

(v) When the effective weighting factor, $WF_{E,i}$, for each mode is calculated for the single filter method, the following shall apply.

$$\text{(A)}\quad \text{WF}_{E,i} = \frac{(\text{m sample kg}_i)(\text{m mix kg /hr avg})}{(\text{m sample kg})(\text{m mix kg /hr}_i)}$$

(B) The value of the effective weighting factors shall be within ±0.005 (absolute value) of the weighting factors listed in Table E–3.

(b) A particulate index for each requested rated speed and horsepower shall be the value determined in paragraph (a)(9)(iii)(C) of this section for the multiple filter method or paragraph (a)(9)(iv)(B) of this section for the single filter method.

(1) Particulate indices less than 20,000 cfm shall be rounded up to the next 500 cfm. Example: 10,432 cfm shall be listed 10,500 cfm.

(2) Particulate indices greater than 20,000 cfm shall be rounded up to the nearest thousand 1,000 cfm. Example: 26,382 cfm shall be listed 27,000 cfm.

[61 FR 55504, Oct. 25, 1996; 62 FR 34640, June 27, 1997]

§ 7.90 Approval marking.

Each approved diesel engine shall be identified by a legible and permanent approval marking inscribed with the assigned MSHA approval number and securely attached to the diesel engine. The marking shall also contain the following information:

(a) Ventilation rate.

(b) Rated power.

(c) Rated speed.

(d) High idle.

(e) Maximum altitude before deration.

(f) Engine model number.

§ 7.91 Post-approval product audit.

Upon request by MSHA, but no more than once a year except for cause, the approval holder shall make a diesel engine available for audit at no cost to MSHA.

§ 7.92 New technology.

MSHA may approve a diesel engine that incorporates technology for which the requirements of this subpart are not applicable if MSHA determines that the diesel engine is as safe as those which meet the requirements of this subpart.

Subpart F—Diesel Power Packages Intended for Use in Areas of Underground Coal Mines Where Permissible Electric Equipment is Required

SOURCE: 61 FR 55518, Oct. 25, 1996, unless otherwise noted.

§ 7.95 Purpose and effective date.

Part 7, subpart A general provisions apply to subpart F. Subpart F establishes the specific requirements for MSHA approval of diesel power packages intended for use in approved equipment in areas of underground coal mines where electric equipment is required to be permissible. It is effective November 25, 1996.

§ 7.96 Definitions.

In addition to the definitions in subparts A and E of this part, the following definitions apply in this subpart.

Cylindrical joint. A joint comprised of two contiguous, concentric, cylindrical surfaces.

Diesel power package. A diesel engine with an intake system, exhaust system, and a safety shutdown system installed.

Dry exhaust conditioner. An exhaust conditioner that cools the exhaust gas without direct contact with water.

Exhaust conditioner. An enclosure, containing a cooling system, through which the exhaust gases pass.

Exhaust system. A system connected to the outlet of the diesel engine which includes, but is not limited to, the exhaust manifold, the exhaust pipe, the exhaust conditioner, the exhaust flame arrester, and any adapters between the exhaust manifold and exhaust flame arrester.

Fastening. A bolt, screw, or stud used to secure adjoining parts to prevent the escape of flame from the diesel power package.

Flame arrester. A device so constructed that flame or sparks from the diesel engine cannot propagate an explosion of a flammable mixture through it.

Flame arresting path (explosion-proof joint). Two or more adjoining or adjacent surfaces between which the escape of flame is prevented.

Flammable mixture. A mixture of methane or natural gas with normal air, that will propagate flame or explode when ignited.

Grade. The slope of an incline expressed as a percent.

High idle speed. The maximum no load speed specified by the engine manufacturer.

Intake system. A system connected to the inlet of the diesel engine which includes, but is not limited to, the intake manifold, the intake flame arrester, the emergency intake air shutoff device, the air cleaner, and all piping and adapters between the intake manifold and air cleaner.

Plane joint. A joint comprised of two adjoining surfaces in parallel planes.

Safety shutdown system. A system which, in response to signals from various safety sensors, recognizes the existence of a potential hazardous condition and automatically shuts off the fuel supply to the engine.

Step (rabbet) joint. A joint comprised of two adjoining surfaces with a change or changes in direction between its inner and outer edges. A step joint may be composed of a cylindrical portion and a plane portion or of two or more plane portions.

Threaded joint. A joint consisting of a male- and female-threaded member, both of which are the same type and gauge.

Wet exhaust conditioner. An exhaust conditioner that cools the exhaust gas through direct contact with water, commonly called a water scrubber.

§ 7.97 Application requirements.

(a) An application for approval of a diesel power package shall contain sufficient information to document compliance with the technical requirements of this subpart and include:

drawings, specifications, and descriptions with dimensions (including tolerances) demonstrating compliance with the technical requirements of § 7.98. The specifications and descriptions shall include the materials of construction and quantity. These shall include the following—

(1) A general arrangement drawing showing the diesel power package and the location and identification of the intake system, exhaust system, safety shutdown system sensors, flame arresters, exhaust conditioner, emergency intake air shutoff device, automatic fuel shutoff device and the engine.

(2) Diesel engine specifications including the MSHA approval number, the engine manufacturer, the engine model number, and the rated speed, rated horsepower, and fuel rate.

(3) A drawing(s) which includes the fan blade material specifications, the location and identification of all water-cooled components, coolant lines, radiator, surge tank, temperature sensors, and orifices; arrows indicating proper flow direction; the height relationship of water-cooled components to the surge tank; and the proper procedure for filling the cooling system.

(4) A drawing(s) showing the relative location, identification of components, and design of the safety shutdown system.

(5) Specific component identification, or specific information including detail drawings that identify the characteristics of the cooling system and safety shutdown system that ensures compliance with the technical requirements.

(6) Detail drawings of gaskets used to form flame-arresting paths.

(7) An assembly drawing showing the location and identification of all intake system components from the air cleaner to the engine head.

(8) An assembly drawing showing the location and identification of all exhaust system components from the engine head to the exhaust outlet.

(9) Detail drawings of those intake and exhaust system components identified in paragraphs (a)(7) and (a)(8) of this section that ensure compliance with the technical requirements. An exhaust conditioner assembly drawing shall be provided showing the location, dimensions, and identification of all internal parts, exhaust inlet and outlet, sensors, and the exhaust gas path through the exhaust conditioner. If a wet exhaust conditioner is used, the exhaust conditioner assembly drawing must also show the location, dimensions, and identification of the fill port, drain port, low water check port; high or normal operating water level; minimum allowable low water level; and the maximum allowable grade that maintains explosion-proof operations.

(10) A power package checklist which shall consist of a list of specific features that must be checked and tests that must be performed to determine if a previously approved diesel power package is in approved condition. Test procedures shall be specified in sufficient detail to allow the evaluation to be made without reference to other documents. Illustrations shall be used to fully identify the approved configuration of the diesel power package.

(11) Information showing that the electrical systems and components meet the requirements of § 7.98.

(12) A drawing list consisting of a complete list of those drawings and specifications which show the details of the construction and design of the diesel power package.

(b) Composite drawings specifying the required construction details may be submitted instead of the individual drawings in paragraph (a) of this section.

(c) All documents shall be titled, dated, numbered, and include the latest revision.

(d) When all testing has been completed, the following information shall be submitted and become part of the approval documentation:

(1) The settings of any adjustable devices used to meet the performance requirements of this subpart.

(2) The coolant temperature sensor setting and exhaust gas temperature sensor setting used to meet the performance requirements of this subpart.

(3) The minimum allowable low water level and the low water sensor setting used to meet the performance requirements of this subpart for systems using a wet exhaust conditioner as the exhaust flame arrester.

(4) The maximum grade on which the wet exhaust conditioner can be operated retaining the flame arresting characteristics.

(5) A finalized version of the power package checklist.

§ 7.98 Technical requirements.

(a) The diesel power package shall use a category A diesel engine approved under subpart E of this part with the following additional requirements:

(1) A hydraulic, pneumatic, or other mechanically actuated starting mechanism. Other means of starting shall be evaluated in accordance with the provisions of § 7.107.

(2) If an air compressor is provided, the intake air line shall be connected to the engine intake system between the air cleaner and the flame arrester. If the air compressor's inlet air line is not connected to the engine's intake system, it shall have an integral air filter.

(b) The temperature of any external surface of the diesel power package shall not exceed 302 °F (150 °C).

(1) Diesel power package designs using water jacketing to meet this requirement shall be tested in accordance with § 7.101.

(2) Diesel power packages using other techniques will be evaluated under the provisions of § 7.107.

(3) When using water-jacketed components, provisions shall be made for positive circulation of coolant, venting of the system to prevent the accumulation of air pockets, and effective activation of the safety shutdown system before the temperature of the coolant in the jackets exceeds the manufacturer's specifications or 212 °F (100 °C), whichever is lower.

(c) External rotating parts shall not be constructed of aluminum alloys containing more than 0.6 percent magnesium.

(d) If nonmetallic rotating parts are used, they shall be provided with a means to prevent an accumulation of static electricity. Static conducting materials shall have a total resistance of 1 megohm or less, measured with an applied potential of 500 volts or more. Static conducting materials having a total resistance greater than 1 megohm will be evaluated under the provisions of § 7.107.

(e) All V-belts shall be static conducting and have a resistance not exceeding 6 megohms, when measured with a direct current potential of 500 volts or more.

(f) The engine crankcase breather shall not be connected to the air intake system of the engine. The discharge from the breather shall be directed away from hot surfaces of the engine and exhaust system.

(g) Electrical components on diesel power packages shall be certified or approved by MSHA under parts 7, 18, 20, and 27 of this chapter.

(h) Electrical systems on diesel power packages consisting of electrical components, interconnecting wiring, and mechanical and electrical protection shall meet the requirements of parts 7, 18, and 27 of this chapter, as applicable.

(i) The diesel power package shall be equipped with a safety shutdown system which will automatically shut off the fuel supply and stop the engine in response to signals from sensors indicating—

(1) The coolant temperature limit specified in paragraph (b) of this section;

(2) The exhaust gas temperature limit specified in paragraph (s)(4) of this section;

(3) The minimum allowable low water level, for a wet exhaust conditioner, as established by tests in § 7.100. Restarting of the engine shall be prevented until the water level in the wet exhaust conditioner has been replenished above the minimum allowable low water level; and

(4) The presence of other safety hazards such as high methane concentration, actuation of the fire suppression system, etc., if such sensors are included in the safety shutdown system.

(j) The safety shutdown system shall have the following features:

(1) A means to automatically disable the starting circuit and prevent engagement of the starting mechanism while the engine is running, or a starting mechanism constructed of nonsparking materials.

(2) If the design of the safety shutdown system requires that the lack of

engine oil pressure must be overridden to start the engine, the override shall not be capable of overriding any of the safety shutdown sensors specified in paragraph (i) of this section.

(k) The diesel power package shall be explosion-proof as determined by the tests set out in § 7.100.

(l) Engine joints that directly or indirectly connect the combustion chamber to the surrounding atmosphere shall be explosion-proof in accordance with paragraphs (m) through (q) of this section and § 7.100. This paragraph does not apply to the following:

(1) Pistons to piston rings;

(2) Pistons to cylinder walls;

(3) Piston rings to cylinder walls;

(4) Cylinder head to cylinder block;

(5) Valve stem to valve guide; or

(6) Injector body to cylinder head.

(m) Each segment of the intake system and exhaust system required to provide explosion-proof features shall be constructed of metal and designed to withstand a minimum internal pressure equal to four times the maximum pressure observed in that segment in tests under § 7.100 or a pressure of 150 psig, whichever is less. Castings shall be free from blowholes.

(n) Welded joints forming the explosion-proof intake and exhaust systems shall be continuous and gas-tight. At a minimum, they shall be made in accordance with American Welding Society Standard D14.4–77 or meet the test requirements of § 7.104 with the internal pressure equal to four times the maximum pressure observed in tests under § 7.100 or a pressure of 150 psig, whichever is less.

(o) Flexible connections shall be permitted in segments of the intake and exhaust systems required to provide explosion-proof features, provided that failure of the connection activates the safety shutdown system before the explosion-proof characteristics are lost.

(p) Flame-arresting paths in the intake and exhaust systems shall be formed either by—

(1) Flanged metal to metal joints meeting the requirements of paragraph (q) of this section; or

(2) Metal flanges fitted with metal gaskets and meeting the following requirements:

(i) Flat surfaces between bolt holes that form any part of a flame-arresting path shall be planed to within a maximum deviation of one-half the maximum clearance specified in paragraph (q)(7) of this section. All metal surfaces forming a flame-arresting path shall be finished during the manufacturing process to not more than 250 microinches.

(ii) A means shall be provided to ensure that fastenings maintain the tightness of joints. The means provided shall not lose its effectiveness through repeated assembly and disassembly.

(iii) Fastenings shall be as uniform in size as practicable to preclude improper assembly.

(iv) Holes for fastenings shall not penetrate to the interior of an intake or exhaust system and shall be threaded to ensure that all specified bolts or screws will not bottom even if the washers are omitted.

(v) Fastenings used for joints of flame-arresting paths on intake or exhaust systems shall be used only for attaching parts that are essential in maintaining the explosion-proof integrity. They shall not be used for attaching brackets or other parts.

(vi) The minimum thickness of material for flanges shall be ½-inch, except that a final thickness of 7⁄16-inch is allowed after machining rolled plate.

(vii) The maximum fastening spacing shall be 6 inches.

(viii) The minimum diameter of fastenings shall be ⅜-inch, except smaller diameter fastenings may be used if the joint first meets the requirements of the static pressure test in § 7.104, and the explosion test in § 7.100.

(ix) The minimum thread engagement of fastenings shall be equal to or greater than the nominal diameter of the fastenings specified, or the intake or exhaust system must meet the test requirements of the explosion tests in § 7.100 and the static pressure test in § 7.104.

(x) The minimum contact surface of gaskets forming flame-arresting paths shall be ⅜-inch, and the thickness of the gaskets shall be no greater than 1⁄16-inch. The minimum distance from the interior edge of a gasket to the edge of a fastening hole shall be ⅜-inch. The gaskets shall be positively positioned, and a means shall be provided to preclude improper installation. When the joint is completely assembled, it shall be impossible to insert a 0.0015-inch thickness gauge to a depth exceeding ⅛-inch between the gasket and mating flanges. Other gasket designs shall be evaluated in accordance with § 7.107.

(q) The following construction requirements shall apply to flame-arresting paths formed without gaskets:

(1) Flat surfaces between fastening holes that form any part of a flame-arresting path shall be planed to within a maximum deviation of one-half the maximum clearance specified in paragraph (q)(7) of this section. All metal surfaces forming a flame-arresting path shall be finished during the manufacturing process to not more than 250 microinches. A thin film of nonhardening preparation to inhibit rusting may be applied to these finished metal surfaces, as long as the final surface can be readily wiped free of any foreign materials.

(2) A means shall be provided to ensure that fastenings maintain the tightness of joints. The means provided shall not lose its effectiveness through repeated assembly and disassembly.

(3) Fastenings shall be as uniform in size as practicable to preclude improper assembly.

(4) Holes for fastenings shall not penetrate to the interior of an intake or exhaust system and shall be threaded to ensure that all specified bolts or screws will not bottom even if the washers are omitted.

(5) Fastenings used for joints of flame-arresting paths on intake or exhaust systems shall be used only for attaching parts that are essential in maintaining the explosion-proof integrity. They shall not be used for attaching brackets or other parts.

(6) The flame-arresting path of threaded joints shall conform to the requirements of paragraph (q)(7) of this section.

(7) Intake and exhaust systems joints shall meet the specifications set out in Table F–1.

TABLE F–1—DIMENSIONAL REQUIREMENTS FOR EXPLOSION-PROOF INTAKE AND EXHAUST SYSTEM JOINTS

Minimum thickness of material for flanges	½″[1]
Minimum width of joint; all in one plane	1″
Maximum clearance; joint all in one plane	0.004″
Minimum width of joint, portions of which are different planes; cylinders or equivalent	¾″[2]
Maximum clearances; joint in two or more planes, cylinders or equivalent:	
Portion perpendicular to plane	0.008″[3]
Plane portion	0.006″
Maximum fastening[4] spacing; joints all in one plane[5]	6″
Maximum fastening spacing; joints, portions of which are in different planes	8″
Minimum diameter of fastening (without regard to type of joint)[6]	⅜″
Minimum thread engagement of fastening[7]	⅜″
Maximum diametrical clearance between fastening body and unthreaded holes through which it passes[8,9,10].	1⁄16″
Minimum distance from interior of the intake or exhaust system to the edge of a fastening hole:[11]	
Joint-minimum width 1″	7⁄16″[8,12]
Shafts centered by ball or roller bearings:	
Minimum length of flame-arresting path	1″
Maximum diametrical clearance	0.030″
Other cylindrical joints:	
Minimum length of flame-arresting path	1″
Maximum diametrical clearance	0.010″

[1] 1⁄16-inch less is allowable for machining rolled plate.

[2] If only two planes are involved, neither portion of a joint shall be less than ⅛-inch wide, unless the wider portion conforms to the same requirements as those for a joint that is all in one plane. If more than two planes are involved (as in labyrinths or tongue-in-groove joints), the combined lengths of those portions having prescribed clearances are considered.

[3] The allowable diametrical clearance is 0.008-inch when the portion perpendicular to the plane portion is ¼-inch or greater in length. If the perpendicular portion is more than ⅛-inch but less than ¼-inch wide, the diametrical clearance shall not exceed 0.006-inch.

[4] Studs, when provided, shall bottom in blind holes, be completely welded in place, or have the bottom of the hole closed with a plug secured by weld or braze. Fastenings shall be provided at all corners.

[5] The requirements as to diametrical clearance around the fastening and minimum distance from the fastening hole to the inside of the intake or exhaust system apply to steel dowel pins. In addition, when such pins are used, the spacing between centers of the fastenings on either side of the pin shall not exceed 5 inches.
[6] Fastening diameters smaller than specified may be used if the joint or assembly meets the test requirements of § 7.104.
[7] Minimum thread engagement shall be equal to or greater than the nominal diameter of the fastening specified, or the intake or exhaust system must meet the test requirements of § 7.104.
[8] The requirements as to diametrical clearance around the fastening and minimum distance from the fastening hole to the inside of the intake or exhaust system apply to steel dowel pins. In addition, when such pins are used, the spacing between centers of the fastenings on either side of the pin shall not exceed 5 inches.
[9] This maximum clearance only applies when the fastening is located within the flame-arresting path.
[10] Threaded holes for fastenings shall be machined to remove burrs or projections that affect planarity of a surface forming a flame-arresting path.
[11] Edge of the fastening hole shall include any edge of any machining done to the fastening hole, such as chamfering.
[12] If the diametrical clearance for fastenings does not exceed 1⁄32-inch, then the minimum distance shall be 1⁄4-inch.

(r) *Intake system.* (1) The intake system shall include a device between the air cleaner and intake flame arrester, operable from the equipment operator's compartment, to shut off the air supply to the engine for emergency purposes. Upon activation, the device must operate immediately and the engine shall stop within 15 seconds.

(2) The intake system shall include a flame arrester that will prevent an explosion within the system from propagating to a surrounding flammable mixture when tested in accordance with the explosion tests in § 7.100. The flame arrester shall be located between the air cleaner and the intake manifold and shall be attached so that it can be removed for inspection or cleaning. The flame arrester shall be constructed of corrosion-resistant metal and meet the following requirements:

(i) Two intake flame arrester designs, the spaced-plate type and the crimped ribbon type, will be tested in accordance with the requirements of § 7.100. Variations to these designs or other intake flame arrester designs will be evaluated under the provisions of § 7.107.

(ii) In flame arresters of the spaced-plate type, the thickness of the plates shall be at least 0.125-inch; spacing between the plates shall not exceed 0.018-inch; and the flame-arresting path formed by the plates shall be at least 1 inch wide. The unsupported length of the plates shall be short enough that permanent deformation resulting from explosion tests shall not exceed 0.002-inch. The plates and flame arrester housing shall be an integral unit which cannot be disassembled.

(iii) In flame arresters of the crimped ribbon type, the dimensions of the core openings shall be such that a plug gauge 0.018-inch in diameter shall not pass through, and the flame-arresting path core thickness shall be at least 1 inch. The core and flame arrester housing shall be an integral unit which cannot be disassembled.

(3) The intake system shall be designed so that improper installation of the flame arrester is impossible.

(4) The intake system shall include an air cleaner service indicator. The air cleaner shall be installed so that only filtered air will enter the flame arrester. The air cleaner shall be sized and the service indicator set in accordance with the engine manufacturer's recommendations. Unless the service indicator is explosion-proof, it shall be located between the air cleaner and flame arrester, and the service indicator setting shall be reduced to account for the additional restriction imposed by the flame arrester.

(5) The intake system shall include a connection between the intake flame arrester and the engine head for temporary attachment of a device to indicate the total vacuum in the system. This opening shall be closed by a plug or other suitable device that is sealed or locked in place except when in use.

(s) *Exhaust system.* (1) The exhaust system shall include a flame arrester that will prevent propagation of flame or discharge of glowing particles to a surrounding flammable mixture. The flame arrester shall be constructed of corrosion-resistant metal.

(i) If a mechanical flame arrester is used, it shall be positioned so that only cooled exhaust gas at a maximum temperature of 302 °F (150 °C) will be discharged through it.

(ii) If a mechanical flame arrester of the spaced-plate type is used, it must meet the requirements of paragraph (r)(2)(ii) of this section and the test requirements of § 7.100. Variations to the spaced-plate flame arrester design and other mechanical flame arrester designs shall be evaluated under the provisions of §7.107. The flame arrester shall be designed and attached so that it can be removed for inspection and cleaning.

(2) The exhaust system shall allow a wet exhaust conditioner to be used as the exhaust flame arrester provided that the explosion tests of §7.100 demonstrate that the wet exhaust conditioner will arrest flame. When used as a flame arrester, the wet exhaust conditioner shall be equipped with a sensor to automatically activate the safety shutdown system at or above the minimum allowable low water level established by §7.100. Restarting of the engine shall be prevented until the water supply in the wet exhaust conditioner has been replenished above the minimum allowable low water level. All parts of the wet exhaust conditioner and associated components that come in contact with contaminated exhaust conditioner water shall be constructed of corrosion-resistant material. The wet exhaust conditioner shall include a means for verifying that the safety shutdown system operates at the proper water level. A means shall be provided for draining and cleaning the wet exhaust conditioner. The final exhaust gas temperature at discharge from the wet exhaust conditioner shall not exceed 170 °F (76 °C) under test conditions specified in §7.102. A sensor shall be provided that activates the safety shutdown system before the exhaust gas temperature at discharge from the wet exhaust conditioner exceeds 185 °F (85 °C) under test conditions specified in §7.103(a)(4).

(3) The exhaust system shall be designed so that improper installation of the flame arrester is impossible.

(4) The exhaust system shall provide a means to cool the exhaust gas and prevent discharge of glowing particles.

(i) When a wet exhaust conditioner is used to cool the exhaust gas and prevent the discharge of glowing particles, the temperature of the exhaust gas at the discharge from the exhaust conditioner shall not exceed 170 °F (76 °C) when tested in accordance with the exhaust gas cooling efficiency test in §7.102. A sensor shall be provided that activates the safety shutdown system before the exhaust gas temperature at discharge from the wet exhaust conditioner exceeds 185 °F (85 °C) when tested in accordance with the safety system controls test in §7.103. All parts of the wet exhaust conditioner and associated components that come in contact with contaminated exhaust conditioner water shall be constructed of corrosion-resistant material.

(ii) When a dry exhaust conditioner is used to cool the exhaust gas, the temperature of the exhaust gas at discharge from the diesel power package shall not exceed 302 °F (150 °C) when tested in accordance with the exhaust gas cooling efficiency test of §7.102. A sensor shall be provided that activates the safety shutdown system before the exhaust gas exceeds 302 °F (150 °C) when tested in accordance with the safety system control test in §7.103. A means shall be provided to prevent the discharge of glowing particles, and it shall be evaluated under the provisions of §7.107.

(5) Other means for cooling the exhaust gas and preventing the propagation of flame or discharge of glowing particles shall be evaluated under the provisions of §7.107.

(6) There shall be a connection in the exhaust system for temporary attachment of a device to indicate the total backpressure in the system and collection of exhaust gas samples. This opening shall be closed by a plug or other suitable device that is sealed or locked in place except when in use.

[61 FR 55518, Oct. 25, 1996, 62 FR 34640, 34641, June 27, 1997]

§7.99 Critical characteristics.

The following critical characteristics shall be inspected or tested on each diesel power package to which an approval marking is affixed:

(a) Finish, width, planarity, and clearances of surfaces that form any part of a flame-arresting path.

(b) Thickness of walls and flanges that are essential in maintaining the explosion-proof integrity of the diesel power package.

(c) Size, spacing, and tightness of fastenings.

(d) The means provided to maintain tightness of fastenings.

(e) Length of thread engagement on fastenings and threaded parts that ensure the explosion-proof integrity of the diesel power package.

(f) Diesel engine approval marking.

(g) Fuel rate setting to ensure that it is appropriate for the intended application, or a warning tag shall be affixed to the fuel system notifying the purchaser of the need to make proper adjustments.

(h) Material and dimensions of gaskets that are essential in maintaining the explosion-proof integrity of the diesel power package.

(i) Dimensions and assembly of flame arresters.

(j) Materials of construction to ensure that the intake system, exhaust system, cooling fans, and belts have been fabricated from the required material.

(k) Proper interconnection of the coolant system components and use of specified components.

(l) Proper interconnection of the safety shutdown system components and use of specified components.

(m) All plugs and covers to ensure that they are tightly installed.

(n) The inspections and tests described in the diesel power package checklist shall be performed and all requirements shall be met.

§ 7.100 Explosion tests.

(a) *Test procedures.* (1) Prepare to test the diesel power package as follows:

(i) Perform a detailed check of parts against the drawings and specifications submitted under §7.97 to determine that the parts and drawings agree.

(ii) Remove all parts that do not contribute to the operation or ensure the explosion-proof integrity of the diesel power package such as the air cleaner and exhaust gas dilution system.

(iii) Fill coolant system fluid and engine oil to the engine manufacturer's recommended levels.

(iv) Interrupt fuel supply to the injector pump.

(v) Establish a preliminary low water level for systems using the wet exhaust conditioner as a flame arrester.

(2) Perform static and dynamic tests of the intake system as follows:

(i) Install the diesel power package in an explosion test chamber which is large enough to contain the complete diesel power package. The chamber must be sufficiently darkened and provide viewing capabilities of the flame-arresting paths to allow observation during testing of any discharge of flame or ignition of the flammable mixture surrounding the diesel power package. Couple the diesel power package to an auxiliary drive mechanism. Attach a pressure measuring device, a temperature measuring device, and an ignition source to the intake system. The pressure measuring device shall be capable of indicating the peak pressure accurate to ±1 pound-per-square inch gauge (psig) at 100 psig static pressure and shall have a frequency response of 40 Hertz or greater. The ignition source shall be an electric spark with a minimum energy of 100 millijoules. The ignition source shall be located immediately adjacent to the intake manifold and the pressure and temperature devices shall be located immediately adjacent to the flame arrester.

(ii) For systems using the wet exhaust conditioner as an exhaust flame arrester, fill the exhaust conditioner to the specified high or normal operating water level.

(iii) Fill the test chamber with a mixture of natural gas and air or methane and air. If natural gas is used, the content of combustible hydrocarbons shall total at least 98.0 percent, by volume, with the remainder being inert. At least 80.0 percent, by volume, of the gas shall be methane. For all tests, the methane or natural gas concentration shall be 8.5 ±1.8 percent, by volume, and the oxygen concentration shall be no less than 18 percent, by volume.

(iv) Using the auxiliary drive mechanism, motor the engine to fill the intake and exhaust systems with the flammable mixture. The intake system, exhaust system, and test chamber gas concentration shall not differ by more than ±0.3 percent, by volume, at the time of ignition.

(v) For static tests, stop the engine, actuate the ignition source, and observe the peak pressure. The peak pressure shall not exceed 110 psig. If the peak pressure exceeds 110 psig, construction changes shall be made that result in a reduction of pressure to 110 psig or less, or the system shall be tested in accordance with the static pressure test of § 7.104 with the pressure parameter replaced with a static pressure of twice the highest value recorded.

(vi) If the peak pressure does not exceed 110 psig or if the system meets the static pressure test requirements of this section and there is no discharge of visible flames or glowing particles or ignition of the flammable mixture in the chamber, a total of 20 tests shall be conducted in accordance with the explosion test specified above.

(vii) For dynamic tests, follow the same procedures for static tests, except actuate the ignition source while motoring the engine. Forty dynamic tests shall be conducted at two speeds, twenty at 1800 ±200 RPM and twenty at 1000 ±200 RPM. Under some circumstances, during dynamic testing the flammable mixture may continue to burn within the diesel power package after ignition. This condition can be recognized by the presence of a rumbling noise and a rapid increase in temperature. This can cause the flame-arrester to reach temperatures which can ignite the surrounding flammable mixture. Ignition of the flammable mixture in the test chamber under these circumstances does not constitute failure of the flame arrester. However; if this condition is observed, the test operator should immediately stop the engine and allow components to cool to prevent damage to the components.

(3) Perform static and dynamic tests of the exhaust system as follows:

(i) Prepare the diesel power package for explosion tests according to § 7.100(a)(2)(i) as follows:

(A) Install the ignition source immediately adjacent to the exhaust manifold.

(B) Install pressure measuring devices in each segment as follows: immediately adjacent to the exhaust conditioner inlet; in the exhaust conditioner; and immediately adjacent to the flame arrester, if applicable.

(C) Install a temperature device immediately adjacent to the exhaust conditioner inlet.

(ii) If the exhaust system is provided with a spaced-plate flame arrester in addition to an exhaust conditioner, explosion tests of the exhaust system shall be performed as described for the intake system in accordance with this section. Water shall not be present in a wet exhaust conditioner for the tests.

(iii) If the wet exhaust conditioner is used as the exhaust flame arrester, explosion testing of this type of system shall be performed as described for the intake system in accordance with this section with the following modifications:

(A) Twenty static tests, twenty dynamic tests at 1800 ±200 RPM, and twenty dynamic tests at 1000 ±200 RPM shall be conducted at 2 inches below the minimum allowable low water level. All entrances in the wet exhaust conditioner which do not form explosion-proof joints shall be opened. These openings may include lines which connect the reserve water supply to the wet exhaust conditioner, insert flanges, float flanges, and cover plates. These entrances are opened during this test to verify that they are not flame paths.

(B) Twenty static tests, twenty dynamic tests at 1800 ±200 RPM, and twenty dynamic tests at 1000 ±200 RPM shall be conducted at 2 inches below the minimum allowable low water level. All entrances in the wet exhaust conditioner (except the exhaust conditioner outlet) which do not form explosion-proof joints shall be closed. These openings are closed to simulate normal operation.

(C) Twenty static tests, twenty dynamic tests at 1800 ±200 RPM, and twenty dynamic tests at 1000 ±200 RPM shall be conducted at the specified high or normal operating water level. All entrances in the wet exhaust conditioner which do not form explosion-proof joints shall be opened.

(D) Twenty static tests, twenty dynamic tests at 1800 ±200 RPM, and twenty dynamic tests at 1000 ±200 RPM shall be conducted at the specified high or normal operating water level. All entrances in the wet exhaust conditioner (except the exhaust conditioner outlet) which do not form explosion-proof joints shall be closed.

(iv) After successful completion of the explosion tests of the exhaust system, the minimum allowable low water level, for a wet exhaust conditioner used as the exhaust flame arrester, shall be determined by adding two inches to the lowest water level that passed the explosion tests.

(v) A determination shall be made of the maximum grade on which the wet exhaust conditioner can be operated retaining the flame-arresting characteristics.

(b) *Acceptable performance.* The explosion tests shall not result in any of the following—

(1) Discharge of flame or glowing particles.

(2) Visible discharge of gas through gasketed joints.

(3) Ignition of the flammable mixture in the test chamber.

(4) Rupture of any part that affects the explosion-proof integrity.

(5) Clearances, in excess of those specified in this subpart, along accessible flame-arresting paths, following any necessary retightening of fastenings.

(6) Pressure exceeding 110 psig, unless the intake system or exhaust system has withstood a static pressure of twice the highest value recorded in the explosion tests of this section following the static pressure test procedures of § 7.104.

(7) Permanent distortion of any planar surface of the diesel power package exceeding 0.04-inches/linear foot.

(8) Permanent deformation exceeding 0.002-inch between the plates of spaced-plate flame arrester designs.

[61 FR 55518, Oct. 25, 1996; 62 FR 34641, June 27, 1997]

§ 7.101 Surface temperature tests.

The test for determination of exhaust gas cooling efficiency described in § 7.102 may be done simultaneously with this test.

(a) *Test procedures.* (1) Prepare to test the diesel power package as follows:

(i) Perform a detailed check of parts against the drawings and specifications submitted to MSHA under compliance with § 7.97 to determine that the parts and drawings agree.

(ii) Fill the coolant system with a mixture of equal parts of antifreeze and water, following the procedures specified in the application, § 7.97(a)(3).

(iii) If a wet exhaust conditioner is used to cool the exhaust gas, fill the exhaust conditioner to the high or normal operating water level and have a reserve water supply available, if applicable.

(2) Tests shall be conducted as follows:

(i) The engine shall be set to the rated horsepower specified in § 7.97(a)(2).

(ii) Install sufficient temperature measuring devices to determine the location of the highest coolant temperature. The temperature measuring devices shall be accurate to ±4 °F (±2 °C).

(iii) Operate the engine at rated horsepower and with 0.5 ±0.1 percent, by volume, of methane in the intake air mixture until all parts of the engine, exhaust coolant system, and other components reach their respective equilibrium temperatures. The liquid fuel temperature into the engine shall be maintained at 100 °F (38 °C) ±10 °F (6 °C) and the intake air temperature shall be maintained at 70 °F (21 °C) ±5 °F (3 °C).

(iv) Increase the coolant system temperatures until the highest coolant temperature is 205 °F to 212 °F (96 °C to 100 °C), or to the maximum temperature specified by the applicant, if lower.

(v) After all coolant system temperatures stabilize, operate the engine for 1 hour.

(vi) The ambient temperature shall be between 50 °F (10 °C) and 104 °F (40 °C) throughout the tests.

(b) *Acceptable performance.* The surface temperature of any external surface of the diesel power package shall not exceed 302 °F (150 °C) during the test.

§ 7.102 Exhaust gas cooling efficiency test.

(a) *Test procedures.* (1) Follow the procedures specified in § 7.101(a).

(2) Install a temperature measuring device to measure the exhaust gas temperature at discharge from the exhaust conditioner. The temperature measuring device shall be accurate to ±4 °F (±2 °C).

(3) Determine the exhaust gas temperature at discharge from the exhaust conditioner before the exhaust gas is diluted with air.

(b) *Acceptable performance.* (1) The exhaust gas temperature at discharge from a wet exhaust conditioner before the exhaust gas is diluted with air shall not exceed 170 °F (76 °C).

(2) The exhaust gas temperature at discharge from a dry exhaust conditioner before the gas is diluted with air shall not exceed 302 °F (150 °C).

§ 7.103 Safety system control test.

(a) *Test procedures.* (1) Prior to testing, perform the tasks specified in § 7.101(a)(1) and install sufficient temperature measuring devices to measure the highest coolant temperature and exhaust gas temperature at discharge from the exhaust conditioner. The temperature measuring devices shall be accurate to ±4 °F (±2 °C).

(2) Determine the effectiveness of the coolant system temperature shutdown sensors which will automatically activate the safety shutdown system and stop the engine before the coolant temperature in the cooling jackets exceeds manufacturer's specifications or 212 °F (100 °C), whichever is lower, by operating the engine and causing the coolant in the cooling jackets to exceed the specified temperature.

(3) For systems using a dry exhaust gas conditioner, determine the effectiveness of the temperature sensor in the exhaust gas stream which will automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas temperature exceeds 302 °F (150 °C), by operating the engine and causing the cooled exhaust gas to exceed the specified temperature.

(4) For systems using a wet exhaust conditioner, determine the effectiveness of the temperature sensor in the exhaust gas stream which will automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas temperature exceeds 185 °F (85 °C), with the engine operating at a high idle speed condition. Temporarily disable the reserve water supply, if applicable, and any safety shutdown system control that might interfere with the evaluation of the operation of the exhaust gas temperature sensor. Prior to testing, set the water level in the wet exhaust conditioner to a level just above the minimum allowable low water level. Run the engine until the exhaust gas temperature sensor activates the safety shutdown system and stops the engine.

(5) For systems using a wet exhaust conditioner as an exhaust flame arrester, determine the effectiveness of the low water sensor which will automatically activate the safety shutdown system and stop the engine at or above the minimum allowable low water level established from results of the explosion tests in § 7.100 with the engine operating at a high idle speed condition. Temporarily disable the reserve water supply, if applicable, and any safety shutdown system control that might interfere with the evaluation of the operation of the low water sensor. Prior to testing, set the water level in the wet exhaust conditioner to a level just above the minimum allowable low water level. Run the engine until the low water sensor activates the safety shutdown system and stops the engine. Measure the low water level. Attempt to restart the engine.

(6) Determine the effectiveness of the device in the intake system which is designed to shut off the air supply and stop the engine for emergency purposes with the engine operating at both a high idle speed condition and a low idle speed condition. Run the engine and activate the emergency intake air shutoff device.

(7) Determine the total air inlet restriction of the complete intake system, including the air cleaner, as measured between the intake flame arrester and the engine head with the engine operating at maximum air flow.

(8) Determine the total exhaust backpressure with the engine operating at rated horsepower as specified in § 7.103(a)(7). If a wet exhaust conditioner is used, it must be filled to the high or normal operating water level during this test.

(9) The starting mechanism shall be tested to ensure that engagement is not possible while the engine is running. Operate the engine and attempt to engage the starting mechanism.

(10) Where the lack of engine oil pressure must be overridden in order to start the engine, test the override to ensure that it does not override any of the safety shutdown sensors specified in § 7.98(i). After each safety shutdown sensor test specified in paragraphs

(a)(2) through (a)(5) of this section, immediately override the engine oil pressure and attempt to restart the engine.

(b) *Acceptable performance.* Tests of the safety system controls shall result in the following:

(1) The coolant system temperature shutdown sensor shall automatically activate the safety shutdown system and stop the engine before the water temperature in the cooling jackets exceeds manufacturer's specifications or 212 °F (100 °C), whichever is lower.

(2) The temperature sensor in the exhaust gas stream of a system using a dry exhaust conditioner shall automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas exceeds 302 °F (150 °C).

(3) The temperature sensor in the exhaust gas stream of a system using a wet exhaust conditioner shall automatically activate the safety shutdown system and stop the engine before the cooled exhaust gas exceeds 185 °F (85 °C).

(4) The low water sensor for systems using a wet exhaust conditioner shall automatically activate the safety shutdown system and stop the engine at or above the minimum allowable low water level and prevent restarting of the engine.

(5) The emergency intake air shutoff device shall operate immediately when activated and stop the engine within 15 seconds.

(6) The total intake air inlet restriction and the total exhaust backpressure shall not exceed the engine manufacturer's specifications.

(7) It shall not be possible to engage the starting mechanism while the engine is running, unless the starting mechanism is constructed of nonsparking material.

(8) The engine oil pressure override shall not override any of the shutdown sensors.

§ 7.104 Internal static pressure test.

(a) *Test procedures.* (1) Isolate and seal each segment of the intake system or exhaust system to allow pressurization.

(2) Internally pressurize each segment of the intake system or exhaust system to four times the maximum pressure observed in each segment during the tests of § 7.100, or 150 psig ±5 psig, whichever is less. Maintain the pressure for a minimum of 10 seconds.

(3) Following the pressure hold, the pressure shall be removed and the pressurizing agent removed from the intake system or exhaust system.

(b) *Acceptable performance.* (1) The intake system or exhaust system, during pressurization, shall not exhibit—

(i) Leakage through welds and gasketed joints; or

(ii) Leakage other than along joints meeting the explosion-proof requirements of § 7.98(q).

(2) Following removal of the pressurizing agent, the intake system or exhaust system shall not exhibit any—

(i) Changes in fastening torque;

(ii) Visible cracks in welds;

(iii) Permanent deformation affecting the length or gap of any flame-arresting paths;

(iv) Stretched or bent fastenings;

(v) Damaged threads of parts affecting the explosion-proof integrity of the intake system or exhaust system; or

(vi) Permanent distortion of any planar surface of the diesel power package exceeding 0.04-inches/linear foot.

§ 7.105 Approval marking.

Each approved diesel power package shall be identified by a legible and permanent approval plate inscribed with the assigned MSHA approval number and securely attached to the diesel power package in a manner that does not impair any explosion-proof characteristics. The grade limitation of a wet exhaust conditioner used as an exhaust flame arrester shall be included on the approval marking.

§ 7.106 Post-approval product audit.

Upon request by MSHA, but not more than once a year except for cause, the approval-holder shall make an approved diesel power package available for audit at no cost to MSHA.

§ 7.107 New technology.

MSHA may approve a diesel power package that incorporates technology for which the requirements of this subpart are not applicable if MSHA determines that the diesel power package is as safe as those which meet the requirements of this subpart.

§ 7.108 Power package checklist.

Each diesel power package bearing an MSHA approval plate shall be accompanied by a power package checklist. The power package checklist shall consist of a list of specific features that must be checked and tests that must be performed to determine if a previously approved diesel power package is in approved condition. Test procedures shall be specified in sufficient detail to allow evaluation to be made without reference to other documents. Illustrations shall be used to fully identify the approved configuration of the diesel power package.

Subpart J—Electric Motor Assemblies

SOURCE: 57 FR 61193, Dec. 23, 1992, unless otherwise noted.

§ 7.301 Purpose and effective date.

This subpart establishes the specific requirements for MSHA approval of certain explosion-proof electric motor assemblies intended for use in approved equipment in underground mines. Applications for approval or extensions of approval submitted after February 22, 1996 shall meet the requirements of this part. Those motors that incorporate features not specifically addressed in this subpart will continue to be evaluated under part 18 of this chapter.

§ 7.302 Definitions.

The following definitions apply in this subpart:

Afterburning. The combustion of any flammable mixture that is drawn into an enclosure after an internal explosion in the enclosure. This condition is determined through detection of secondary pressure peaks occurring subsequent to the initial explosion.

Cylindrical joint. A joint comprised of two contiguous, concentric, cylindrical surfaces.

Explosion-proof enclosure. A metallic enclosure used as a winding compartment, conduit box, or a combination of both that complies with the applicable requirements of §7.304 of this part and is constructed so that it will withstand the explosion tests of §7.306 of this part.

Fastening. A bolt, screw, or stud used to secure adjoining parts to prevent the escape of flame from an explosion-proof enclosure.

Flame-arresting path. Two or more adjoining or adjacent surfaces between which the escape of flame is prevented.

Internal free volume (of an empty enclosure). The volume remaining after deducting the volume of any part that is essential in maintaining the explosion-proof integrity of the enclosure or necessary for operation of the motor. Essential parts include the parts that constitute the flame-arresting path and those necessary to secure parts that constitute a flame-arresting path.

Motor assembly. The winding compartment including a conduit box when specified. A motor assembly is comprised of one or more explosion-proof enclosures.

Plane joint. A joint comprised of two adjoining surfaces in parallel planes.

Step (rabbet) joint. A joint comprised of two adjoining surfaces with a change or changes in direction between its inner and outer edges. A step joint may be composed of a cylindrical portion and a plane portion or of two or more plane portions.

Stuffing box. An entrance with a recess filled with packing material for cables extending through a wall of an explosion-proof enclosure.

Threaded joint. A joint consisting of a male- and a female-threaded member, both of which are the same type and gauge.

§ 7.303 Application requirements.

(a) An application for approval of a motor assembly shall include a composite drawing or drawings with the following information:

(1) Model (type), frame size, and rating of the motor assembly.

(2) Overall dimensions of the motor assembly, including conduit box if applicable, and internal free volume.

(3) Material and quantity for each of the component parts that form the explosion-proof enclosure or enclosures.

(4) All dimensions (including tolerances) and specifications required to

ascertain compliance with the requirements of § 7.304 of this part.

(b) All drawings shall be titled, dated, numbered, and include the latest revision.

§ 7.304 Technical requirements.

(a) Voltage rating of the motor shall not exceed 4160 volts.

(b) The temperature of the external surfaces of the motor assembly shall not exceed 150 °C (302 °F) when operated at the manufacturers' specified ratings.

(c) Minimum clearances between uninsulated electrical conductor surfaces, or between uninsulated conductor surfaces and grounded metal surfaces, within the enclosure shall meet the requirements of table J–1 of this section.

TABLE J–1—MINIMUM CLEARANCES BETWEEN UNINSULATED SURFACES

Phase-to-phase voltage (rms)	Clearances (inches)	
	Phase-to-phase	Phase-to-ground or control circuit
0 to 250	0.25	0.25
251 to 600	0.28	0.25
601 to 1000	0.61	0.25
1001 to 2400	1.4	0.6
2401 to 4160	3.0	1.4

(d) Parts whose dimensions can change with the motor operation, such as ball and roller bearings and oil seals, shall not be used as flame-arresting paths.

(e) The widths of any grooves, such as grooves for holding oil seals or o-rings, shall be deducted in measuring the widths of flame-arresting paths.

(f) An outer bearing cap shall not be considered as forming any part of a flame-arresting path unless the cap is used as a bearing cartridge.

(g) Requirements for explosion-proof enclosures of motor assemblies.

(1) Enclosures shall be—

(i) Constructed of metal;

(ii) Designed to withstand a minimum internal pressure of 150 pounds per square inch (gauge);

(iii) Free from blowholes when cast; and

(iv) Explosion proof as determined by the tests set out in § 7.306 of this part.

(2) Welded joints forming an enclosure shall be—

(i) Continuous and gas-tight; and

(ii) Made in accordance with or exceed the American Welding Society Standard AWS D14.4–77, ''Classification and Application of Welded Joints for Machinery and Equipment,'' or meet the test requirements set out in § 7.307 of this part. AWS D14.4–77 is incorporated by reference and has been approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be obtained from the American Welding Society, Inc., 2501 NW 7th Street, Miami, FL 33125. Copies may be inspected at the U.S. Department of Labor, Mine Safety and Health Administration, Approval and Certification Center, 765 Technology Drive, Triadelphia, WV 26059, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(3) External rotating parts shall not be constructed of aluminum alloys containing more than 0.6 percent magnesium. Non-metallic rotating parts shall be provided with a means to prevent an accumulation of static electricity.

(4) Threaded covers and mating parts shall be designed with Class 1A and 1B (coarse, loose fitting) threads. The covers shall be secured against loosening.

(5) Flat surfaces between fastening holes that form any part of a flame-arresting path shall be plane to within a maximum deviation of one-half the maximum clearance specified in paragraph (g)(19) of this section. All surfaces forming a flame-arresting path shall be finished during the manufacturing process to not more than 250 microinches. A thin film of nonhardening preparation to inhibit rusting may be applied to these finished metal surfaces as long as the final surface can be readily wiped free of any foreign materials.

(6) For a laminated stator frame, it shall be impossible to insert a 0.0015 inch thickness gauge to a depth exceeding ⅛ inch between adjacent laminations or between end rings and laminations.

(7) Lockwashers, or equivalent, shall be provided for all fastenings. Devices other than lockwashers shall meet the requirements of § 7.308 of this part. Equivalent devices shall only be used in the configuration in which they were tested.

(8) Fastenings shall be as uniform in size as practicable to preclude improper installation.

(9) Holes for fastenings in an explosion-proof enclosure shall be threaded to ensure that all specified bolts or screws will not bottom even if the washers are omitted.

(10) Holes for fastenings shall not penetrate to the interior of an explosion-proof enclosure, except holes made through motor casings for bolts, studs, or screws to hold essential parts, such as pole pieces, brush rigging, and bearing cartridges. The attachments of such parts shall be secured against loosening. The threaded holes in these parts shall be blind unless the fastenings are inserted from the inside, in which case the fastenings shall not be accessible with the rotor in place.

(11) For direct current motor assemblies with narrow interpoles, the distance from the edge of the pole piece to any bolt hole in the frame shall be at least ⅛ inch. If the distance is ⅛ to ¼ inch, the diametrical clearance for the pole bolt shall not exceed 1/64 inch for not less than ½ inch through the frame. Furthermore, the pole piece shall have the same radius as the inner surface of the frame. Pole pieces may be shimmed as necessary. If used, the total resulting thickness of the shims shall be specified. The shim assembly shall meet the same requirements as the pole piece.

(12) Coil-thread inserts, if used in holes for fastenings, shall meet the following:

(i) The inserts shall have internal screw threads.

(ii) The holes for the inserts shall be drilled and tapped consistent with the insert manufacturer's specifications.

(iii) The inserts shall be installed consistent with the insert manufacturer's specifications.

(iv) The insert shall be of sufficient length to ensure the minimum thread engagement of fastening specified in paragraph (g)(19) of this section.

(13) A minimum of ⅛ inch of stock shall be left at the center of the bottom of each blind hole that could penetrate into the interior of an explosion-proof enclosure.

(14) Fastenings shall be used only for attaching parts that are essential in maintaining the explosion-proof integrity of the enclosure, or necessary for the operation of the motor. They shall not be used for making electrical connections.

(15) Through holes not in use shall be closed with a metal plug. Plugs, including eyebolts, in through holes where future access is desired shall meet the flame-arresting paths, lengths, and clearances of paragraph (g)(19) of this section and be secured by spot welding or brazing. The spot weld or braze may be on a plug, clamp, or fastening (for example see figure J–1). Plugs for holes where future access is not desired shall be secured all around by a continuous gas-tight weld.

(16) O-rings, if used in a flame-arresting path, shall meet the following:

(i) When the flame-arresting path is in one plane, the o-ring shall be located at least one-half the acceptable flame-arresting path length specified in paragraph (g)(19) of this section from within the outside edge of the path (see figure J–2).

(ii) When the flame-arresting path is one of the plane-cylindrical type (step joint), the o-ring shall be located at least ½ inch from within the outer edge of the plane portion (see figure J–3), or at the junction of the plane and cylindrical portion of the joint (see figure J–4), or in the cylindrical portion (see figure J–5).

(17) Mating parts comprising a pressed fit shall result in a minimum interference of 0.001 inch between the parts. The minimum length of the pressed fit shall be equal to the minimum thickness requirement of paragraph (g)(19) of this section for the material in which the fit is made.

(18) The flame-arresting path of threaded joints shall conform to the requirements of paragraph (g)(19) of this section.

(19) Explosion-proof enclosures shall meet the requirements set out in table

J–2 of this section, based on the internal free volume of the empty enclosure.

TABLE J–2—EXPLOSION-PROOF REQUIREMENTS BASED ON VOLUME

	Volume of empty enclosure		
	Less than 45 cu. ins.	45 to 124 cu. ins. inclusive	More than 124 cu. ins.
Minimum thickness of material for walls [1]	⅛″	3⁄16″	¼″
Minimum thickness of material for flanges and covers	[2] ¼″	[3] ⅜″	[3] ½″
Minimum width of joint; all in one plane	½″	¾″	1″
Maximum clearance; joint all in one plane	0.002″	0.003″	0.004″
Minimum width of joint, portions of which are in different planes; cylinders or equivalent	[4] ⅜″	[4] ⅝″	[4] ¾″
Maximum clearances; joint in two or more planes, cylinders or equivalent: [5]			
(a) Portion perpendicular to plane [6]	0.008″	0.008″	0.008″
(b) Plane portion	0.006″	0.006″	0.006″
Maximum fastening [7,8] spacing; joints all in one plane	([16])	([16])	([16])
Maximum fastening spacing; joints, portions of which are in different planes	([17])	([17])	([17])
Minimum diameter of fastening [9] (without regard to type of joint)	¼″	¼″	⅜″
Minimum thread engagement of fastening [10]	¼″	¼″	⅜″
Maximum diametrical clearance between fastening body and unthreaded holes through which it passes [8,11,12]	1⁄64″	1⁄32″	1⁄16″
Minimum distance from interior of enclosure to the edge of a fastening hole: [8,13]			
Joint—minimum width 1″	....	....	[14] 7⁄16″
Joint—less than 1″ wide	⅛″	3⁄16″	
Cylindrical Joints			
Shaft centered by ball or roller bearings:			
Minimum length of flame-arresting path	½″	¾″	1″
Maximum diametrical clearance	0.020″	0.025″	0.030″
Other cylindrical joints: [15]			
Minimum length of flame-arresting path	½″	¾″	1″
Maximum diametrical clearance	0.006″	0.008″	0.010″

[1] This is the minimal nominal dimension when applied to standard steel plate.
[2] 1⁄32 inch less is allowable for machining rolled plate.
[3] 1⁄16 inch less is allowable for machining rolled plate.
[4] If only two planes are involved, neither portion of a joint shall be less than ⅛ inch wide, unless the wider portion conforms to the same requirements as those for a joint that is all in one plane. If more than two planes are involved (as in labyrinths or tongue-and-groove joints) the combined lengths of those portions having prescribed clearances are considered.
[5] For winding compartments having internal free volume not exceeding 350 cubic inches and joints not exceeding 32 inches in outer circumference and provided with step joints between the stator frame and the end bracket the following dimensions shall apply:

DIMENSIONS OF RABBET (STEP) JOINTS-INCHES

[See figure J–6 in appendix]

Minimum total width	Minimum width of clamped radial portion	Maximum clearance of radial portion	Maximum diametrical clearance at axial portion
⅜	3⁄64	0.0015	0.003
½	3⁄64	0.002	0.003
½	3⁄32	0.002	0.004

[6] The allowable diametrical clearance is 0.008 inch when the portion perpendicular to the plane portion is ¼ inch or greater in length. If the perpendicular portion is more than ⅛ inch but less than ¼ inch wide, the diametrical clearance shall not exceed 0.006 inch.
[7] Studs, when provided, shall bottom in blind holes, be completely welded in place, or have the bottom of the hole closed with a plug secured by weld or braze. Fastenings shall be provided at all corners.
[8] The requirements as to diametrical clearance around the fastening and minimum distance from the fastening hole to the inside of the explosion-proof enclosure apply to steel dowel pins. In addition, when such pins are used, the spacing between centers of the fastenings on either side of the pin shall not exceed 5 inches.
[9] Fastening diameters smaller than specified may be used if the enclosure meets the test requirements of 30 CFR 7.307 and then 7.306 in that order.
[10] Minimum thread engagement shall be equal to or greater than the diameter of the fastening specified, or the enclosure must meet the test requirements of 30 CFR 7.307 and then 7.306 in that order.
[11] This maximum clearance applies only when the fastening is located within the flame-arresting path.
[12] Threaded holes for fastening bolts shall be machined to remove burrs or projections that affect planarity of a surface forming a flame-arresting path.
[13] Edge of the fastening hole shall include the edge of any machining done to the fastening hole, such as chamfering.
[14] If the diametrical clearance for fastenings does not exceed 1⁄32 inch, then the minimum distance shall be ¼ inch.

[15] Shafts or operating rods through journal bearings shall be at least 1/4″ in diameter. The length of the flame-arresting path shall not be reduced when a pushbutton is depressed. Operating rods shall have a shoulder or head on the portion inside the enclosure. Essential parts riveted or bolted to the inside portion are acceptable in lieu of a head or shoulder, but cotter pins and similar devices shall not be used.

[16] 6″ with a minimum of 4 fastenings.

[17] 8″ with a minimum of 4 fastenings.

(h) *Lead entrances.* (1) Each cable, which extends through an outside wall of the motor assembly, shall pass through a stuffing-box lead entrance (see figure J–7). All sharp edges shall be removed from stuffing boxes, packing nuts, and other lead entrance (gland) parts, so that the cable jacket is not damaged.

(2) When the packing is properly compressed, the gland nut shall have—

(i) A clearance distance of 1/8 inch or more, with no maximum, to travel without interference by parts other than packing; and

(ii) A minimum of three effective threads engaged (see figures J–8, J–9, and J–10).

(3) Packing nuts (see figure J–7) and stuffing boxes shall be secured against loosening (see figure J–11).

(4) Compressed packing material shall be in contact with the cable jacket for a length of not less than 1/2 inch.

(5) Requirements for lead entrances in which MSHA accepted rope packing material is specified, are:

(i) Rope packing material shall be acceptable under §18.37(e) of this chapter.

(ii) The width of the space for packing material shall not exceed by more than 50 percent the diameter or width of the uncompressed packing material (see figure J–12).

(iii) The maximum diametrical clearance, using the specified tolerances, between the cable and the through holes in the gland parts adjacent to the packing (stuffing box, packing nut, hose tube, or bushings) shall not exceed 75 percent of the nominal diameter or width of the packing material (see figure J–13).

(6) Requirements for lead entrances in which grommet packing made of compressible material is specified, are:

(i) The grommet packing material shall be accepted by MSHA as flame-resistant material under §18.37(f)(1) of this chapter.

(ii) The diametrical clearance between the cable jacket and the nominal inside diameter of the grommet shall not exceed 1/16 inch, based on the nominal specified diameter of the cable (see figure J–14).

(iii) The diametrical clearance between the nominal outside diameter of the grommet and the inside wall of the stuffing box shall not exceed 1/16 inch (see figure J–14).

(i) *Combustible gases from insulating material.* (1) Insulating materials that give off flammable or explosive gases when decomposed electrically shall not be used within explosion-proof enclosures where the materials are subjected to destructive electrical action.

(2) Parts coated or impregnated with insulating materials shall be treated to remove any combustible solvent before assembly in an explosion-proof enclosure.

[57 FR 61193, Dec. 23, 1992, as amended at 73 FR 52210, Sept. 9, 2008]

§ 7.305 Critical characteristics.

The following critical characteristics shall be inspected on each motor assembly to which an approval marking is affixed:

(a) Finish, width, and planarity of surfaces that form any part of a flame-arresting path.

(b) Clearances between mating parts that form flame-arresting paths.

(c) Thickness of walls, flanges, and covers that are essential in maintaining the explosion-proof integrity of the enclosure.

(d) Spacing of fastenings.

(e) Length of thread engagement on fastenings and threaded parts that assure the explosion-proof integrity of the enclosure.

(f) Use of lockwasher or equivalent with all fastenings.

(g) Dimensions which affect compliance with the requirements for packing gland parts in §7.304 of this part.

§ 7.306 Explosion tests.

(a) The following shall be used for conducting an explosion test:

(1) An explosion test chamber designed and constructed to contain an

explosive gas mixture to surround and fill the motor assembly being tested. The chamber must be sufficiently darkened and provide viewing capabilities of the flame-arresting paths to allow observation during testing of any discharge of flame or ignition of the explosive mixture surrounding the motor assembly.

(2) A methane gas supply with at least 98 by volume per centum of combustible hydrocarbons, with the remainder being inert. At least 80 percent by volume of the gas shall be methane.

(3) Coal dust having a minimum of 22 percent dry volatile matter and a minimum heat constant of 11,000 moist BTU (coal containing natural bed moisture but not visible surface water) ground to a fineness of minus 200 mesh U.S. Standard sieve series.

(4) An electric spark ignition source with a minimum of 100 millijoules of energy.

(5) A pressure recording system that will indicate the pressure peaks resulting from the ignition and combustion of explosive gas mixtures within the enclosure being tested.

(b) *General test procedures.* (1) Motor assemblies being tested shall—

(i) Be equipped with unshielded bearings regardless of the type of bearings specified; and

(ii) Have all parts that do not contribute to the operation or assure the explosion-proof integrity of the enclosure, such as oil seals, grease fittings, hose conduit, cable clamps, and outer bearing caps (which do not house the bearings) removed from the motor assembly.

(2) Each motor assembly shall be placed in the explosion test chamber and tested as follows:

(i) The motor assembly shall be filled with and surrounded by an explosive mixture of the natural gas supply and air. The chamber gas concentrations shall be between 6.0 by volume per centum and the motor assembly natural gas concentration just before ignition of each test. Each externally visible flame-arresting path fit shall be observed for discharge of flames for at least two of the tests, including one with coal dust added.

(ii) A single spark source is used for all testing. Pressure shall be measured at each end of the winding compartment simultaneously during all tests. Quantity and location of test holes shall permit ignition on each end of the winding compartment and recording of pressure on the same and opposite ends as the ignition.

(iii) Motor assemblies incorporating a conduit box shall have the pressure in the conduit box recorded simultaneously with the other measured pressures during all tests. Quantity and location of test holes in the conduit box shall permit ignition and recording of pressure as required in paragraphs (c)(1) and (c)(4)(i) of this section.

(iv) The motor assembly shall be completely purged and recharged with a fresh explosive gas mixture from the chamber or by injection after each test. The chamber shall be completely purged and recharged with a fresh explosive gas mixture as necessary. The oxygen level of the chamber gas mixture shall be no less than 18 percent by volume for testing. In the absence of oxygen monitoring equipment, the maximum number of tests conducted before purging shall be less than or equal to the chamber volume divided by forty times the volume occupied by the motor assembly.

(c) *Test procedures.* (1) Eight tests at 9.4 ±0.4 percent methane by volume within the winding compartment shall be conducted, with the rotor stationary during four tests and rotating at rated speed (rpm) during four tests. The ignition shall be at one end of the winding compartment for two stationary and two rotating tests, and then switched to the opposite end for the remaining four tests. If a nonisolated conduit box is used, then two additional tests, one stationary and one rotating, shall be conducted with ignition in the conduit box at a point furthest away from the opening between the conduit box and the winding compartment.

(2) Four tests at 7.0 ±0.3 percent methane by volume within the winding compartment shall be conducted with the rotor stationary, 2 ignitions at each end.

(3) Four tests at 9.4 ±0.4 percent methane by volume plus coal dust shall be conducted. A quantity of coal dust

equal to 0.05 ounces per cubic foot of internal free volume of the winding compartment plus the nonisolated conduit box shall be introduced into each end of the winding compartment and nonisolated conduit box to coat the interior surface before conducting the first of the four tests. The coal dust introduced into the conduit box shall be proportional to its volume. The remaining coal dust shall be equally divided between the winding compartment ends. For two tests, one stationary and one rotating, the ignition shall be either in the conduit box or one end of the connected winding compartment, whichever produced the highest pressure in the previous tests. The two remaining tests, one stationary and one rotating, shall be conducted with the ignition in the winding compartment end furthest away from the conduit box.

(4) For motor assemblies incorporating a conduit box which is isolated from the winding compartment by an isolating barrier the following additional tests shall be conducted—

(i) For conduit boxes with an internal free volume greater than 150 cubic inches, two ignition points shall be used, one as close to the geometric center of the conduit box as practical and the other at the furthest point away from the isolating barrier between the conduit box and the winding compartment. Recording of pressure shall be on the same and opposite sides as the ignition point furthest from the isolating barrier between the conduit box and the winding compartment. Conduit boxes with an internal free volume of 150 cubic inches or less shall have one test hole for ignition located as close to the geometric center of the conduit box as practical and one for recording of pressure located on a side of the conduit box.

(ii) The conduit box shall be tested separately. Six tests at 9.4 ±0.4 percent methane by volume within the conduit box shall be conducted followed by two tests at 7.0 ±0.3 percent methane by volume. Then two tests at 9.4 ±0.4 percent methane by volume with a quantity of coal dust equal to 0.05 ounces per cubic foot of internal free volume of the conduit box and meeting the specifications in paragraph (c)(3) of this section shall be conducted. For conduit boxes with an internal free volume of more than 150 cubic inches, the number of tests shall be evenly divided between each ignition point.

(iii) The motor assembly shall be tested following removal of the isolating barrier or one sectionalizing terminal (as applicable). Six tests at 9.4 ±0.4 percent methane by volume in the winding compartment and conduit box shall be conducted using three ignition locations. The ignition shall be at one end of the winding compartment for one stationary and one rotating test; the opposite end for one stationary and one rotating test; and at the ignition point that produced the highest pressure on the previous test in paragraph (c)(4)(ii) of this section in the conduit box for one stationary and one rotating test. Motor assemblies that use multiple sectionalizing terminals shall have one test conducted as each additional terminal is removed. Each of these tests shall use the rotor state and ignition location that produced the highest pressure in the previous tests.

(d) A motor assembly incorporating a conduit box that is isolated from the winding compartment that exhibits pressures exceeding 110 psig, while testing during removal of any or all isolating barriers as specified in paragraph (c)(4) of this section, shall have a warning statement on the approval plate. This statement shall warn that the isolating barrier must be maintained to ensure the explosion-proof integrity of the motor assembly. A statement is not required when the motor assembly has withstood a static pressure of twice the maximum pressure recorded in the explosion tests of paragraph (c)(4) of this section. The static pressure test shall be conducted on the motor assembly with all isolating barriers removed, and in accordance with §7.307 of this part.

(e) *Acceptable performance*. Explosion tests of a motor assembly shall not result in—

(1) Discharge of flames.

(2) Ignition of the explosive mixture surrounding the motor assembly in the chamber.

(3) Development of afterburning.

(4) Rupture of any part of the motor assembly or any panel or divider within the motor assembly.

(5) Clearances, in excess of those specified in this subpart, along accessible flame-arresting paths, following any necessary retightening of fastenings.

(6) Pressure exceeding 110 psig, except as provided in paragraph (d) of this section unless the motor assembly has withstood a static pressure of twice the maximum pressure recorded in the explosion tests of this section following the static pressure test procedures of § 7.307 of this part.

(7) Permanent deformation greater than 0.040 inches per linear foot.

§ 7.307 Static pressure test.

(a) *Test procedure.* (1) The enclosure shall be internally pressurized to a minimum of 150 psig and the pressure maintained for a minimum of 10 seconds.

(2) Following the pressure hold, the pressure shall be removed and the pressurizing agent removed from the enclosure.

(b) *Acceptable performance.* (1) The enclosure during pressurization shall not exhibit—

(i) Leakage through welds or casting; or

(ii) Rupture of any part that affects the explosion-proof integrity of the enclosure.

(2) The enclosure following removal of the pressurizing agent shall not exhibit—

(i) Visible cracks in welds;

(ii) Permanent deformation exceeding 0.040 inches per linear foot; or

(iii) Clearances, in excess of those specified in this subpart, along accessible flame-arresting paths, following any necessary retightening of fastenings.

§ 7.308 Lockwasher equivalency test.

(a) *Test procedure.* (1) Each test sample shall be an assembly consisting of a fastening with a locking device. Each standard sample shall be an assembly consisting of a fastening with a lockwasher.

(2) Five standard samples and five test samples shall be tested.

(3) Each standard and test sample shall use a new fastening of the same specifications as being used on the motor assembly.

(4) A new tapped hole shall be used for each standard and test sample. The hole shall be of the same specifications as used on the motor assembly.

(5) Each standard and test sample shall be inserted in the tapped hole and continuously and uniformly tightened at a speed not to exceed 30 rpm until the fastening's proof load is achieved. The torquing device shall not contact the locking device or the threaded portion of the fastening.

(6) Each standard and test sample shall be engaged and disengaged for 15 full cycles.

(b) *Acceptable performance.* The minimum torque value required to start removal of the fastening from the installed position (minimum breakway torque) for any cycle of any test sample shall be greater than or equal to the average breakway torque of each removal cycle of every standard sample.

§ 7.309 Approval marking.

Each approved motor assembly shall be identified by a legible and permanent approval plate inscribed with the assigned MSHA approval number and a warning statement as specified in § 7.306(d) of this part. The plate shall be securely attached to the motor assembly in a manner that does not impair any explosion-proof characteristics.

§ 7.310 Post-approval product audit.

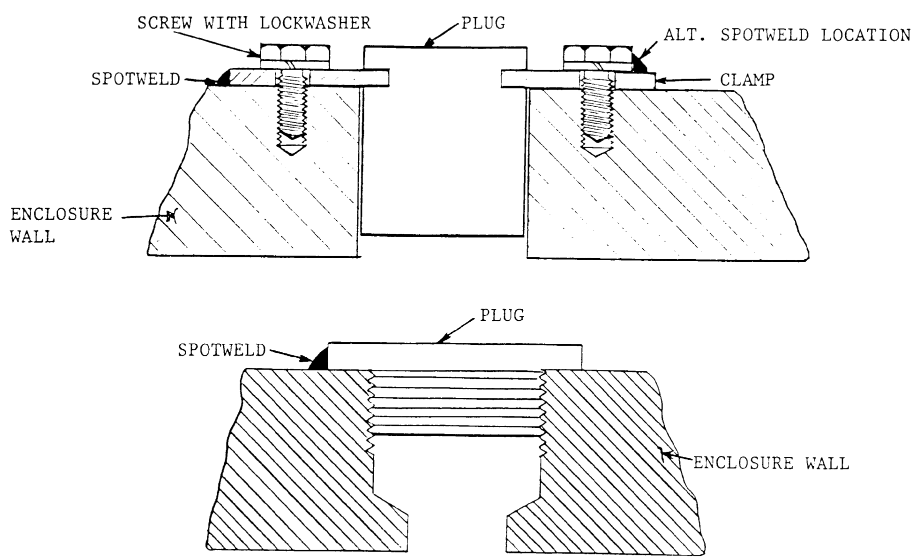
Upon request by MSHA but not more than once a year, except for cause, the approval holder shall make a motor assembly available for audit at no cost.

§ 7.311 Approval checklist.

Each motor assembly bearing an MSHA approval marking shall be accompanied by a list of items necessary for maintenance of the motor assembly as approved.

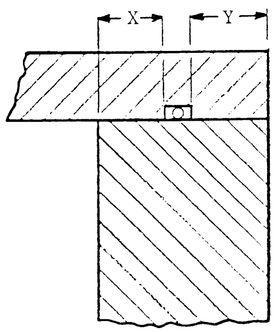
APPENDIX I TO SUBPART J OF PART 7

Appendix I to Subpart J—Figures J–1 through J–14



WELD (OR BRAZE) MAY BE ON PLUG, CLAMP, OR FASTENING

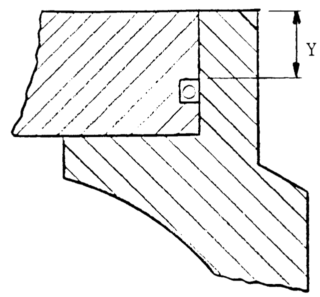
FIGURE J-1



X + Y = MIN. ACCEPTABLE FLAME-ARRESTING PATH LENGTH

$$Y = \frac{X + Y}{2}$$

FIGURE J-2



Y = 1/2" MIN.

FIGURE J-3

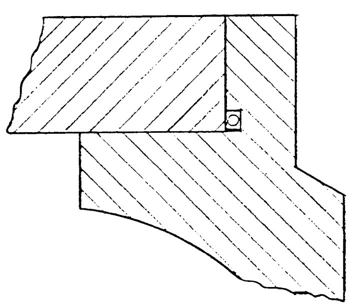
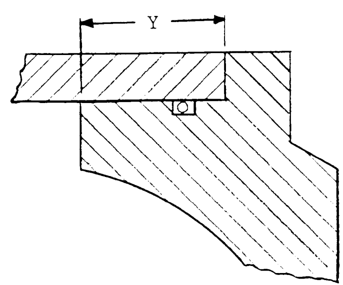
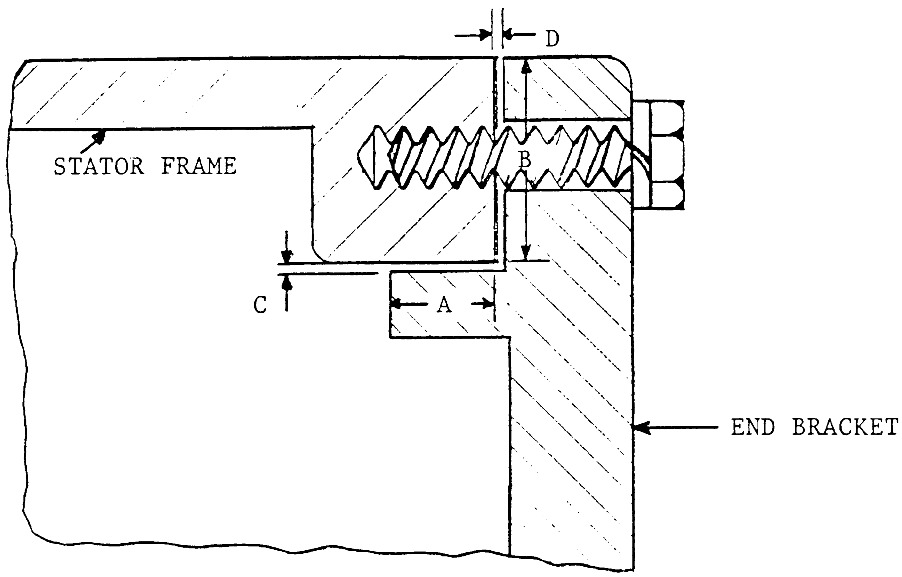


FIGURE J-4



O-RING CAN BE LOCATED ANYWHERE ALONG LENGTH OF (Y).

FIGURE J-5



A = Width of Axial Portion

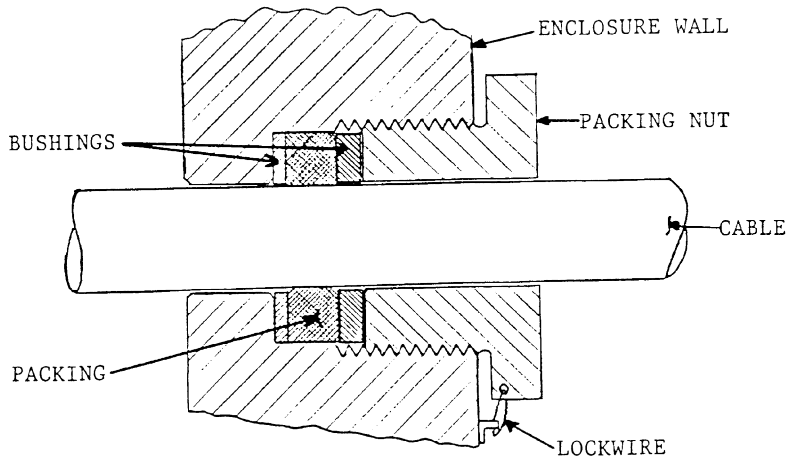
B = Width of Clamped Radial Portion

C = Clearance of Axial Portion

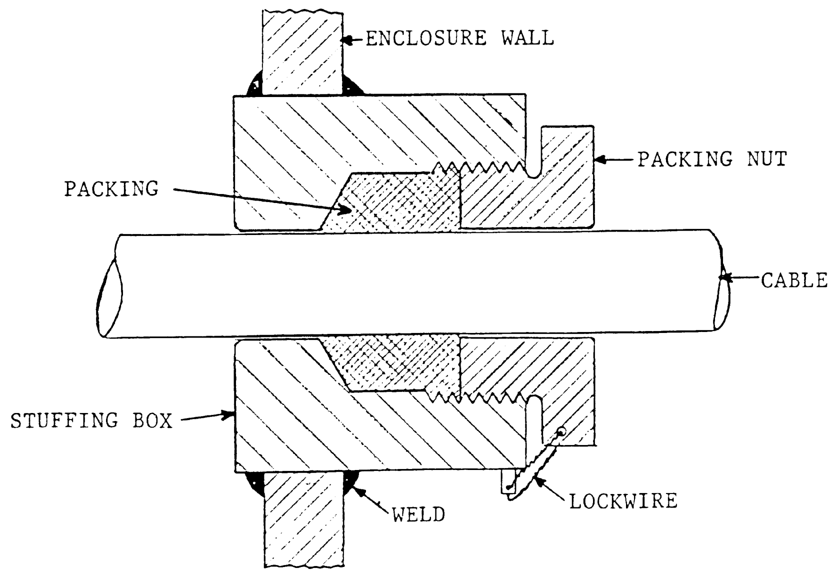
D = Clearance of Radial Portion

Total Width of Flamepath = A + B

FIGURE J-6

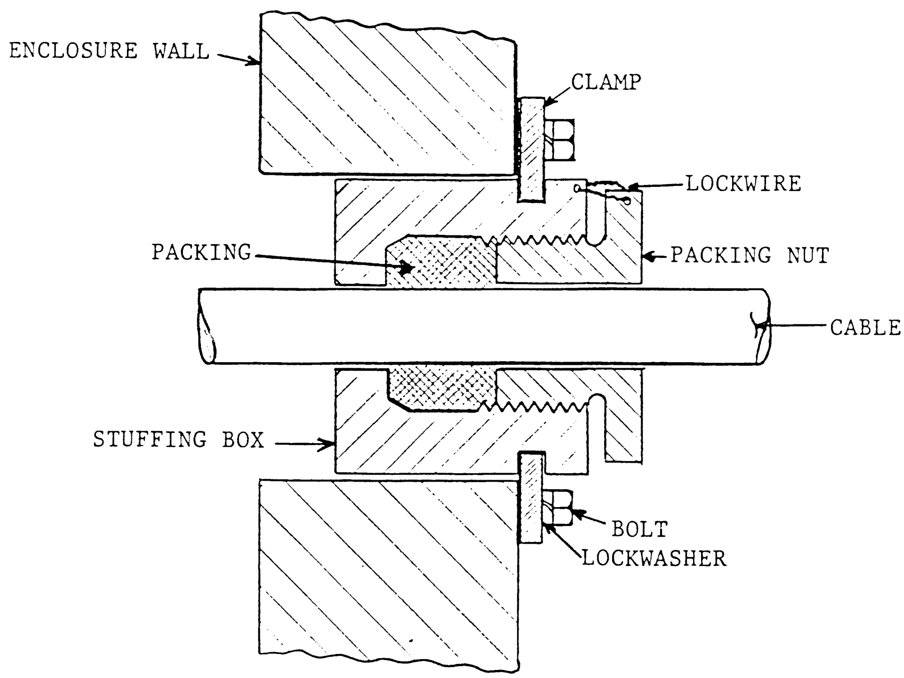


MACHINED-IN STUFFING BOX



WELD-IN STUFFING BOX

FIGURE J-7



SLIP-FIT STUFFING BOX

FIGURE J-7

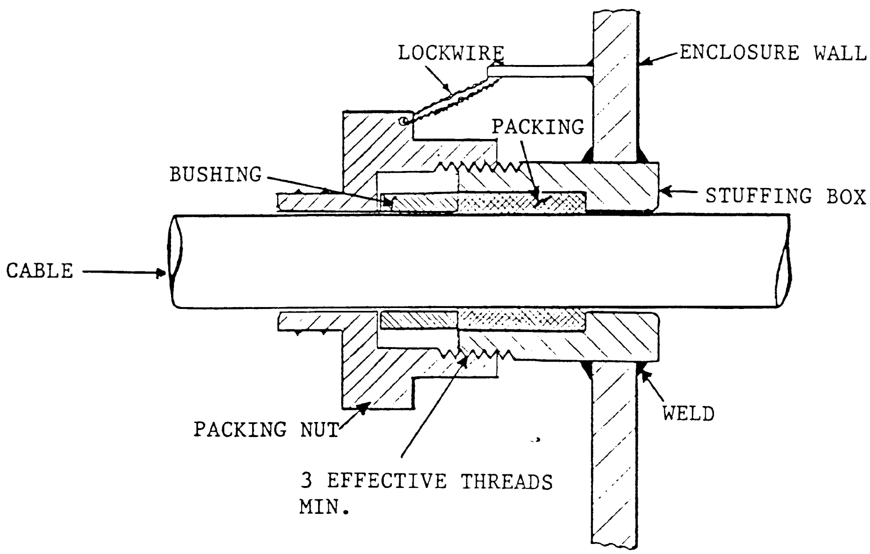


FIGURE J-8

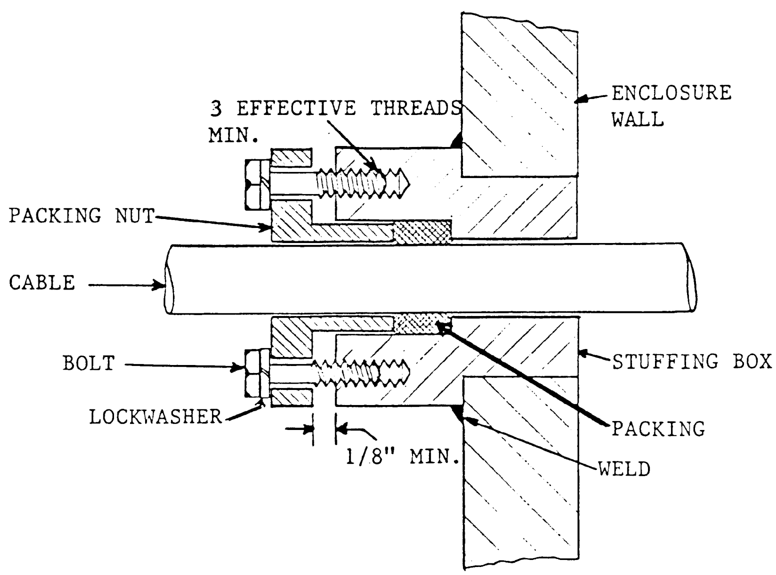


FIGURE J-9

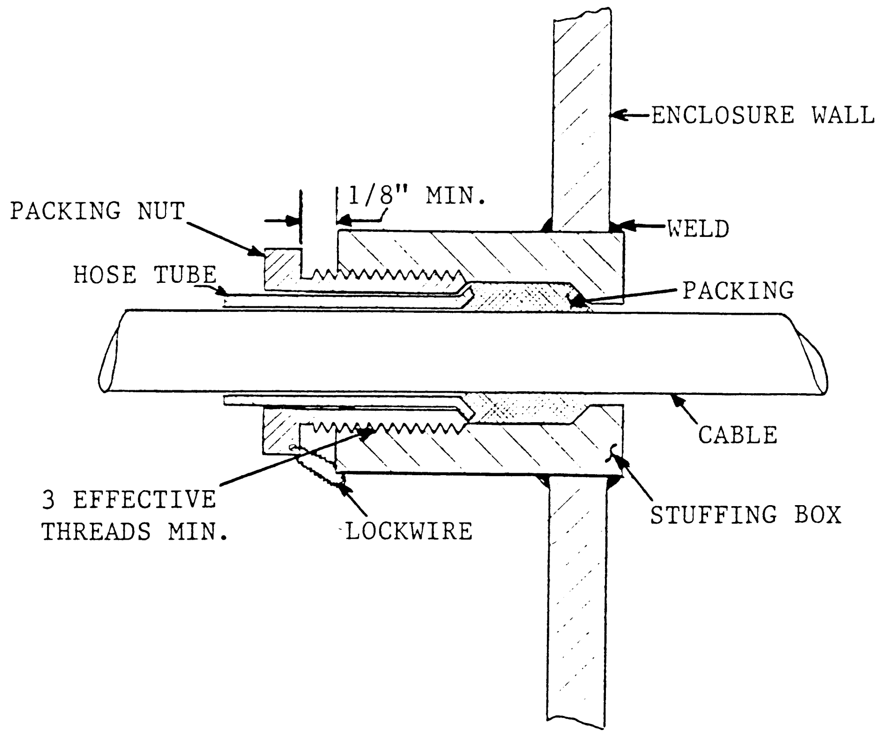

ENCLOSURE WALL
1/8" MIN.
PACKING NUT
WELD
HOSE TUBE
PACKING
CABLE
3 EFFECTIVE THREADS MIN.
LOCKWIRE
STUFFING BOX

FIGURE J-10

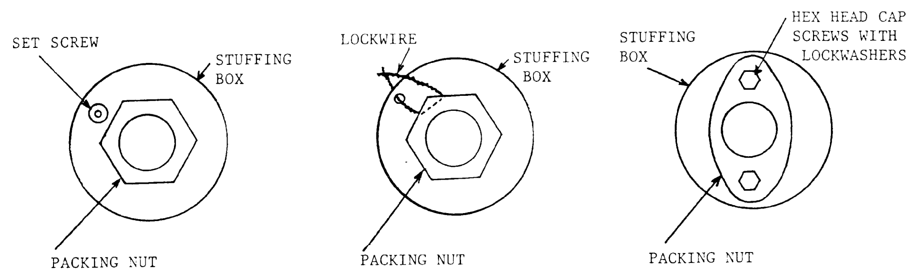
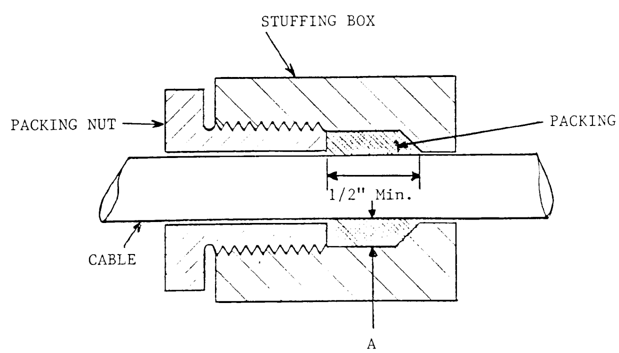
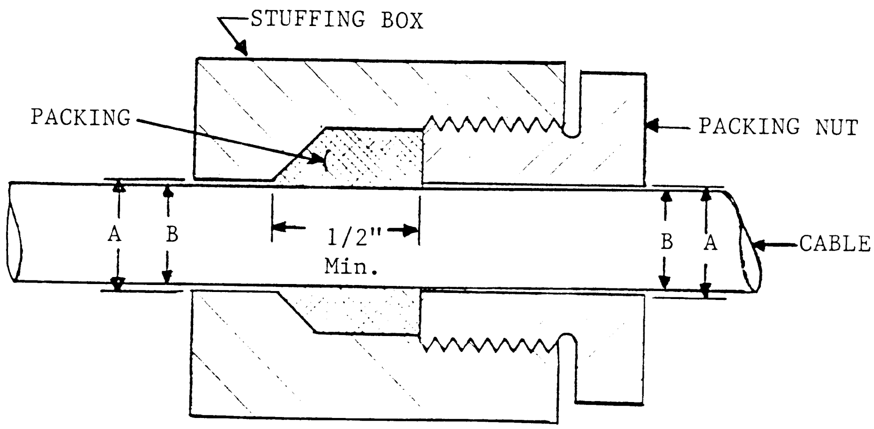


FIGURE J-11



A ≤ 150% of Packing Material Diameter or Width

FIGURE J-12



A - B ≤ 75% of Packing Material Diameter or Width

FIGURE J-13

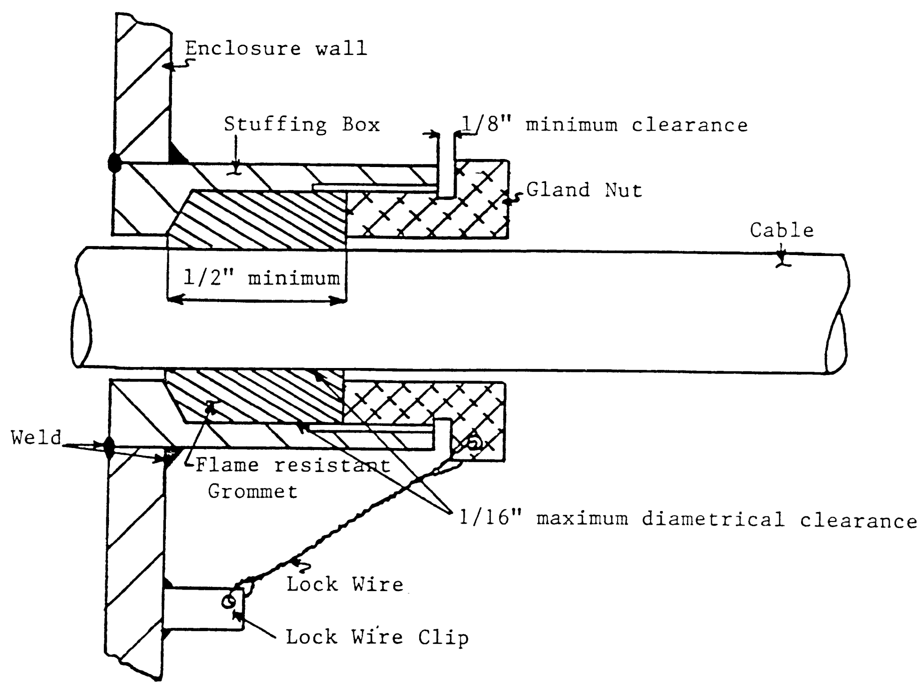


FIGURE J-14

Subpart K—Electric Cables, Signaling Cables, and Cable Splice Kits

SOURCE: 57 FR 61220, Dec. 23, 1992, unless otherwise noted.

§ 7.401 Purpose and effective date.

This subpart establishes the flame-resistant requirements for approval of electric cables, signaling cables and cable splice kit designs. Applications for approval or extension of approval submitted after February 22, 1994 shall meet the requirements of this subpart.

§ 7.402 Definitions.

The following definitions apply in this subpart.

Component. Any material in a cable splice kit which becomes part of a splice.

Conductor. A bare or insulated wire or combination of wires not insulated from one another, suitable for carrying an electric current.

Electric Cable. An assembly of one or more insulated conductors of electric current under a common or integral jacket. A cable may also contain one or more uninsulated conductors.

Jacket. A nonmetallic abrasion-resistant outer covering of a cable or splice.

Power Conductor. An insulated conductor of a cable assembly through which the primary electric current or power is transmitted.

Signaling Cable. A fiber optic cable, or a cable containing electric conductors of a cross-sectional area less than #14 AWG used where the circuit cannot deliver currents which would increase conductor temperatures beyond that established for the current-carrying capacity of the conductors.

Splice. The mechanical joining of one or more severed conductors in a single length of a cable including the replacement of insulation and jacket.

Splice Kit. A group of materials and related instructions which clearly identify all components and detail procedures used in safely making a flame-resistant splice in an electric cable.

§ 7.403 Application requirements.

(a) *Electric cables and signaling cables*. A single application may address two or more sizes, types, and constructions if the products do not differ in composition of materials or basic design. Applications shall include the following information for each product:

(1) Product information:

(i) Cable type (for example, G or G-GC).

(ii) Construction (for example, round or flat).

(iii) Number and size (gauge) of each conductor.

(iv) Voltage rating for all cables containing electric conductors.

(v) For electric cables, current-carrying capacity of each conductor, with corresponding ambient temperature upon which the current rating (ampacity) is based, of each power conductor.

(2) Design standard. Specify any published consensus standard used and fully describe any deviations from it, or fully describe any nonstandard design used.

(3) Materials. Type and identifying numbers for each material comprising the finished assembly.

(b) *Splice kit*. A single application may address two or more sizes, types, and constructions if the products do not differ in composition of materials or basic design. Applications shall include the following information for each product:

(1) Product information:

(i) Trade name or designation (for example, style or code number).

(ii) Type or kit (for example, shielded or nonshielded).

(iii) Voltage rating.

(2) Design standard. Specify any published design standard used and fully describe any deviations from it, or provide complete final assembly dimensions for all components for each cable that the splice kit is designed to repair.

(3) Materials. Type of materials, supplier, supplier's stock number or designation for each component.

(4) Complete splice assembly instructions which clearly identify all components and detail procedures used in making the splice.

§ 7.404 Technical requirements.

(a) Electric cables and splices shall be flame resistant when tested in accordance with § 7.407.

(b) Signaling cables shall be flame resistant when tested in accordance with § 7.408.

§ 7.405 Critical characteristics.

(a) A sample from each production run, batch, or lot of manufactured electric cable, signaling cable, or splice made from a splice kit shall be flame tested, or

(b) A sample of the materials that contribute to the flame-resistant characteristic of the cable or splice and a sample of the cable or splice kit assembly shall be visually inspected or tested through other means for each production run, batch, or lot to ensure that the finished product meets the flame-resistance test.

§ 7.406 Flame test apparatus.

The principal parts of the apparatus used to test for flame resistance of electric cables, signaling cables and splices shall include#:

(a) *Test chamber*. A rectangular enclosure measuring 17 inches deep by 14½ inches high by 39 inches wide and completely open at the top and front. The floor or base of the chamber shall be fabricated or lined with a noncombustible material that will not extinguish burning matter which may fall from the test specimen during testing. The chamber shall have permanent connections mounted to the back wall, sides, or floor of the chamber which extend to the sample end location. These are used to energize the electric cable and splice specimens. They are not used, but may stay in place, when testing signaling cables.

(b) *Specimen holder (support)*. A specimen holder (support) consisting of three separate metal rods each measuring approximately 3⁄16 inch in diameter (nominal) to support the specimen. The horizontal portion of the rod which contacts the test specimen shall be approximately 12 inches in length.

(c) *Gas ignition source.* A standard natural gas type Tirrill burner, with a nominal inside diameter of 3⁄8 inch, to apply the flame to the test specimen. The fuel for the burner shall be natural gas composed of at least 96 percent combustible hydrocarbons, with at least 80 percent being methane.

(d) *Current source.* (For electric cables and splices only). A source of electric current (either alternating current or direct current) for heating the power conductors of the test specimen. The current source shall have a means to regulate current flow through the test specimen and have an open circuit voltage not exceeding the voltage rating of the test specimen.

(e) *Current measuring device.* (For electric cables and splices only). An instrument to monitor the effective value of heating current flow through the power conductors of the specimen within an accuracy of ±1 percent.

(f) *Temperature measuring device.* (For electric cables and splices only). An instrument to measure conductor temperature within an accuracy of ±2 percent without the necessity of removing material from the test specimen in order to measure the temperature.

§ 7.407 Test for flame resistance of electric cables and cable splices.

(a) *Test procedure.* (1) For electric cables, prepare 3 specimens of cable, each 3 feet in length, by removing 5 inches of jacket material and 2½ inches of conductor insulation from both ends of each test specimen. For splices, prepare a splice specimen in each of 3 sections of MSHA-approved flame-resistant cable. The cable shall be of the type that the splice kit is designed to repair. The finished splice shall not exceed 18 inches or be less than 6 inches in length for test purposes. The spliced cables shall be 3 feet in length with the midpoint of the splice located 14 inches from one end. Both ends of each of the spliced cables shall be prepared by removing 5 inches of jacket material and 2½ inches of conductor insulation. The type, amperage, voltage rating, and construction of the cable shall be compatible with the splice kit design. Each splice shall be made in accordance with the instructions provided with the splice kit.

(2) Prior to testing, condition each test specimen for a minimum of 24 hours at a temperature of 70 ±10 °F (21.1 ±5.5 °C) and a relative humidity of 55 ±10 percent. These environmental conditions shall be maintained during testing.

(3) For electric cables, locate the sensing element of the temperature measuring device 26 inches from one end of each test specimen. For splices, locate the sensing element 12 inches from the midpoint of the splice and 10 inches from the end of the cable. The sensing element must be secured so that it remains in direct contact with the metallic portion of the power conductor for the duration of the flame-resistant test. If a thermocouple-type temperature measuring instrument is used, connect the sensing element through the cable jacket and power conductor insulation. Other means for monitoring conductor temperature may be used, provided the temperature measurement is made at the same location. If the jacket and conductor insulation must be disturbed to insert the temperature measuring device, each must be restored as closely as possible to its original location and maintained there for the duration of the testing.

(4) Center the test specimen horizontally in the test chamber on the three rods. The three rods shall be positioned perpendicular to the longitudinal axis of the test specimen and at the same height, which permits the tip of the inner cone from the flame of the gas burner, when adjusted in accordance with the test procedure, to touch the jacket of the test specimen. The specimen shall be maintained at this level for the duration of the flame test. The two outermost rods shall be placed so that 1 inch of cable jacket extends beyond each rod. For electric cables, the third rod shall be placed 14 inches from the end of the test specimen nearer the temperature monitoring location on the specimen. For splices, the third rod shall be placed between the splice and the temperature monitoring

location at a distance 8 inches from the midpoint of the splice. The specimen shall be free from external air currents during testing.

(5) Adjust the gas burner to give an overall blue flame 5 inches high with a 3-inch inner cone. There shall be no persistence of yellow coloration.

(6) Connect all power conductors of the test specimen to the current source. The connections shall be secure and compatible with the size of the cable's power conductors in order to reduce contact resistance.

(7) Energize all power conductors of the test specimen with an effective heating current value of 5 times the power conductor ampacity rating (to the nearest whole ampere) at an ambient temperature of 104 °F (40 °C).

(8) Monitor the electric current through the power conductors of the test specimen with the current measuring device. Adjust the amount of heating current, as required, to maintain the proper effective heating current value within ±5 percent until the power conductors reach a temperature of 400 °F (204.4 °C).

(9) For electric cables, apply the tip of the inner cone from the flame of the gas burner directly beneath the test specimen for 60 seconds at a location 14 inches from one end of the cable and between the supports separated by a 16-inch distance. For splices, apply the tip of the inner cone from the flame of a gas burner for 60 seconds beneath the midpoint of the splice jacket.

(10) After subjecting the test specimen to external flame for the specified time, fully remove the flame of the gas from beneath the specimen without disturbing air currents within the test chamber. Simultaneously turn off the heating current.

(11) Record the amount of time the test specimen continues to burn after the flame from the gas burner has been removed. The duration of burning includes the burn time of any material that falls from the test specimen after the flame from the gas has been removed.

(12) Record the length of burned (charred) area of each test specimen measured longitudinally along the cable axis.

(13) Repeat the procedure for the remaining two specimens.

(b) *Acceptable performance.* Each of the three test specimens shall meet the following criteria:

(1) The duration of burning shall not exceed 240 seconds.

(2) The length of the burned (charred) area shall not exceed 6 inches.

§ 7.408 Test for flame resistance of signaling cables.

(a) *Test procedure.* (1) Prepare 3 samples of cable each 2 feet long.

(2) Prior to testing, condition each test specimen for a minimum of 24 hours at a temperature of 70 ±10 °F (21.1 ±5.5 °C) and relative humidity of 55 ±10 percent. These environmental conditions shall be maintained during testing.

(3) Center the test specimen horizontally in the test chamber on the three rods. The three rods shall be positioned perpendicular to the longitudinal axis of the test specimen and at the same height, which permits the tip of the inner cone from the flame of the gas burner, when adjusted in accordance with the test procedure, to touch the test specimen. The specimen shall be maintained at this height for the duration of the flame test. The two outermost rods shall be placed so that 1 inch of cable extends beyond each rod. The third rod shall be placed at the midpoint of the cable. The specimen shall be free from external air currents during testing.

(4) Adjust the gas burner to give an overall blue flame 5 inches high with a 3-inch inner cone. There shall be no persistence of yellow coloration.

(5) Apply the tip of the inner cone from the flame of the gas burner for 30 seconds directly beneath the specimen centered between either and support and the center support.

(6) After subjecting the test specimen to external flame for the specified time, fully remove the flame of the gas from beneath the specimen without disturbing air currents within the test chamber.

(7) Record the amount of time the test specimen continues to burn after the flame from the gas burner has been removed. The duration of burning includes the burn time of any material

that falls from the test specimen after the flame from the gas has been removed.

(8) Record the length of burned (charred) area of each test specimen measured longitudinally along the cable axis.

(9) Repeat the procedure for the remaining two specimens.

(b) *Acceptable performance.* Each of the three test specimens shall meet the following criteria:

(1) The duration of burning shall not exceed 60 seconds.

(2) The length of the burned (charred) area shall not exceed 6 inches.

§ 7.409 Approval marking.

Approved electric cables, signaling cables, and splices shall be legibly and permanently marked with the MSHA-assigned approval marking. For electric cables and signaling cables, the marking shall appear at intervals not exceeding 3 feet and shall include the MSHA-assigned approval number in addition to the number and size (gauge) of conductors and cable type. For cables containing electric conductors, the marking shall also include the voltage rating. For splices, the marking shall be placed on the jacket so that it will appear at least once on the assembled splice.

§ 7.410 Post-approval product audit.

Upon request by MSHA, but no more than once a year except for cause, the approval holder shall supply to MSHA for audit at no cost—

(a) 12 feet of an approved electric cable or approved signaling cable; or

(b) 3 splice kits of one approved splice kit design and 12 feet of MSHA-assigned cable that the splice kit is designed to repair.

§ 7.411 New technology.

MSHA may approve cable products or splice kits that incorporate technology for which the requirements of this subpart are not applicable if the Agency determines that they are as safe as those which meet the requirements of this subpart.

Subpart L—Refuge Alternatives

SOURCE: 74 FR 80694, Dec. 31, 2008, unless otherwise noted.

§ 7.501 Purpose and scope.

This subpart L establishes requirements for MSHA approval of refuge alternatives and components for use in underground coal mines. Refuge alternatives are intended to provide a life-sustaining environment for persons trapped underground when escape is impossible.

§ 7.502 Definitions.

The following definitions apply in this subpart:

Apparent temperature. A measure of relative discomfort due to the combined effects of air movement, heat, and humidity on the human body.

Breathable oxygen. Oxygen that is at least 99 percent pure with no harmful contaminants.

Flash fire. A fire that rapidly spreads through a diffuse fuel, such as airborne coal dust or methane, without producing damaging pressure.

Noncombustible material. Material, such as concrete or steel, that will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

Overpressure. The highest pressure over the background atmospheric pressure that could result from an explosion, which includes the impact of the pressure wave on an object.

Refuge alternative. A protected, secure space with an isolated atmosphere and integrated components that create a life-sustaining environment for persons trapped in an underground coal mine.

§ 7.503 Application requirements.

(a) An application for approval of a refuge alternative or component shall include:

(1) The refuge alternative's or component's make and model number, if applicable.

(2) A list of the refuge alternative's or component's parts that includes—

(i) The MSHA approval number for electric-powered equipment;

(ii) Each component's or part's in-mine shelf life, service life, and recommended replacement schedule;

(iii) Materials that have a potential to ignite used in each component or part with their MSHA approval number; and

(iv) A statement that the component or part is compatible with other components and, upon replacement, is equivalent to the original component or part.

(3) The capacity and duration (the number of persons it is designed to maintain and for how long) of the refuge alternative or component on a per-person per-hour basis.

(4) The length, width, and height of the space required for storage of each component.

(b) The application for approval of the refuge alternative shall include the following:

(1) A description of the breathable air component, including drawings, air-supply sources, piping, regulators, and controls.

(2) The maximum volume, excluding the airlock; the dimensions of floor space and volume provided for each person using the refuge alternative; and the floor space and volume of the airlock.

(3) The maximum positive pressures in the interior space and the airlock and a description of the means used to limit or control the positive pressure.

(4) The maximum allowable apparent temperature of the interior space and the airlock and the means to control the apparent temperature.

(5) The maximum mine air temperature under which the refuge alternative is designed to operate when the unit is fully occupied.

(6) Drawings that show the features of each component and contain sufficient information to document compliance with the technical requirements.

(7) A manual that contains sufficient detail for each refuge alternative or component addressing in-mine transportation, operation, and maintenance of the unit.

(8) A summary of the procedures for deploying refuge alternatives.

(9) A summary of the procedures for using the refuge alternative.

(10) The results of inspections, evaluations, calculations, and tests conducted under this subpart.

(c) The application for approval of the air-monitoring component shall specify the following:

(1) The operating range, type of sensor, gas or gases measured, and environmental limitations, including the cross-sensitivity to other gases, of each detector or device in the air-monitoring component.

(2) The procedure for operation of the individual devices so that they function as necessary to test gas concentrations over a 96-hour period.

(3) The procedures for monitoring and maintaining breathable air in the airlock, before and after purging.

(4) The instructions for determining the quality of the atmosphere in the airlock and refuge alternative interior and a means to maintain breathable air in the airlock.

(d) The application for approval of the harmful gas removal component shall specify the following:

(1) The volume of breathable air available for removing harmful gas both at start-up and while persons enter through the airlock.

(2) The maximum volume of each gas that the component is designed to remove on a per-person per-hour basis.

§ 7.504 Refuge alternatives and components; general requirements.

(a) *Refuge alternatives and components:* (1) Electrical components that are exposed to the mine atmosphere shall be approved as intrinsically safe for use. Electrical components located inside the refuge alternative shall be either approved as intrinsically safe or approved as permissible.

(2) Shall not produce continuous noise levels in excess of 85 dBA in the structure's interior.

(3) Shall not liberate harmful or irritating gases or particulates into the structure's interior or airlock.

(4) Shall be designed so that the refuge alternative can be safely moved with the use of appropriate devices such as tow bars.

(5) Shall be designed to withstand forces from collision of the refuge alternative structure during transport or handling.

(b) The apparent temperature in the structure shall be controlled as follows:

(1) When used in accordance with the manufacturer's instructions and defined limitations, the apparent temperature in the fully occupied refuge alternative shall not exceed 95 degrees Fahrenheit (°F).

(2) Tests shall be conducted to determine the maximum apparent temperature in the refuge alternative when used at maximum occupancy and in conjunction with required components. Test results including calculations shall be reported in the application.

(c) The refuge alternative shall include:

(1) A two-way communication facility that is a part of the mine communication system, which can be used from inside the refuge alternative; and accommodations for an additional communication system and other requirements as defined in the communications portion of the operator's approved Emergency Response Plan.

(2) Lighting sufficient for persons to perform tasks.

(3) A means to contain human waste effectively and minimize objectionable odors.

(4) First aid supplies.

(5) Materials, parts, and tools for repair of components.

(6) A fire extinguisher that—

(i) Meets the requirements for portable fire extinguishers used in underground coal mines under part 75;

(ii) Is appropriate for extinguishing fires involving the chemicals used for harmful gas removal; and

(iii) Uses a low-toxicity extinguishing agent that does not produce a hazardous by-product when deployed.

(d) Containers used for storage of refuge alternative components or provisions shall be—

(1) Airtight, waterproof, and rodent-proof;

(2) Easy to open and close without the use of tools; and

(3) Conspicuously marked with an expiration date and instructions for use.

§ 7.505 Structural components.

(a) The structure shall—

(1) Provide at least 15 square feet of floor space per person and 30 to 60 cubic feet of volume per person according to the following chart. The airlock can be included in the space and volume if waste is disposed outside the refuge alternative.

Mining height (inches)	Unrestricted volume (cubic feet) per person *
36 or less	30
>36–≤42	37.5
>42–≤48	45
>48–≤54	52.5
>54	60

* Includes an adjustment of 12 inches for clearances.

(2) Include storage space that secures and protects the components during transportation and that permits ready access to components for maintenance examinations.

(3) Include an airlock that creates a barrier and isolates the interior space from the mine atmosphere, except for a refuge alternative capable of maintaining adequate positive pressure.

(i) The airlock shall be designed for multiple uses to accommodate the structure's maximum occupancy.

(ii) The airlock shall be configured to accommodate a stretcher without compromising its function.

(4) Be designed and made to withstand 15 pounds per square inch (psi) overpressure for 0.2 seconds prior to deployment.

(5) Be designed and made to withstand exposure to a flash fire of 300 °F for 3 seconds prior to deployment.

(6) Be made with materials that do not have a potential to ignite or are MSHA-approved.

(7) Be made from reinforced material that has sufficient durability to withstand routine handling and resist puncture and tearing during deployment and use.

(8) Be guarded or reinforced to prevent damage to the structure that would hinder deployment, entry, or use.

(9) Permit measurement of outside gas concentrations without exiting the structure or allowing entry of the outside atmosphere.

(b) Inspections or tests shall be conducted as follows:

(1) A test shall be conducted to demonstrate that trained persons can fully deploy the structure, without the use of tools, within 10 minutes of reaching the refuge alternative.

(2) A test shall be conducted to demonstrate that an overpressure of 15 psi applied to the pre-deployed refuge alternative structure for 0.2 seconds does not allow gases to pass through the structure separating the interior and exterior atmospheres.

(3) A test shall be conducted to demonstrate that a flash fire of 300 °F for 3 seconds does not allow gases to pass from the outside to the inside of the structure.

(4) An inspection shall be conducted to determine that the overpressure forces of 15 psi applied to the pre-deployed refuge alternative structure for 0.2 seconds does not prevent the stored components from operating.

(5) An inspection shall be conducted to determine that a flash fire of 300 °F for 3 seconds does not prevent the stored components from operating.

(6) A test shall be conducted to demonstrate that each structure resists puncture and tearing when tested in accordance with ASTM D2582–07 *Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting*. This publication is incorporated by reference. The Director of the Federal Register approves this incorporation by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. A copy may be obtained from the American Society for Testing Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428–2959. A copy may be inspected at any MSHA Coal Mine Safety and Health district office,; or at MSHA's Office of Standards, 1100 Wilson Blvd., Room 2353, Arlington, Virginia 22209 (phone: 202–693–9440); or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(7) A test shall be conducted to demonstrate that each reasonably anticipated repair can be completed within 10 minutes of opening the storage space for repair materials and tools.

(8) A test shall be conducted to demonstrate that no harmful gases or noticeable odors are released from nonmetallic materials before or after the flash fire test. The test shall identify the gases released and determine their concentrations.

(c) If pressurized air is used to deploy the structure or maintain its shape, the structure shall—

(1) Include a pressure regulator or other means to prevent over pressurization of the structure, and

(2) Provide a means to repair and repressurize the structure in case of failure of the structure or loss of air pressure.

(d) The refuge alternative structure shall provide a means—

(1) To conduct a preshift examination, without entering the structure, of components critical for deployment; and

(2) To indicate unauthorized entry or tampering.

§ 7.506 Breathable air components.

(a) Breathable air shall be supplied by compressed air cylinders, compressed breathable-oxygen cylinders, or boreholes with fans installed on the surface or compressors installed on the surface. Only uncontaminated breathable air shall be supplied to the refuge alternative.

(b) Mechanisms shall be provided and procedures shall be included so that, within the refuge alternative,—

(1) The breathable air sustains each person for 96 hours,

(2) The oxygen concentration is maintained at levels between 18.5 and 23 percent, and

(3) The average carbon dioxide concentration is 1.0 percent or less and excursions do not exceed 2.5 percent.

(c) Breathable air supplied by compressed air from cylinders, fans, or compressors shall provide a minimum flow rate of 12.5 cubic feet per minute of breathable air for each person.

(1) Fans or compressors shall meet the following:

(i) Be equipped with a carbon monoxide detector located at the surface that automatically provides a visual and audible alarm if carbon monoxide in supplied air exceeds 10 parts per million (ppm).

(ii) Provide in-line air-purifying sorbent beds and filters or other equivalent means to assure the breathing air quality and prevent condensation, and include maintenance instructions that provide specifications for periodic replacement or refurbishment.

(iii) Provide positive pressure and an automatic means to assure that the pressure is relieved at 0.18 psi, or as specified by the manufacturer, above mine atmospheric pressure in the refuge alternative.

(iv) Include warnings to assure that only uncontaminated breathable air is supplied to the refuge alternative.

(v) Include air lines to supply breathable air from the fan or compressor to the refuge alternative.

(A) Air lines shall be capable of preventing or removing water accumulation.

(B) Air lines shall be designed and protected to prevent damage during normal mining operations, a flash fire of 300 °F for 3 seconds, a pressure wave of 15 psi overpressure for 0.2 seconds, and ground failure.

(vi) Assure that harmful or explosive gases, water, and other materials cannot enter the breathable air.

(2) Redundant fans or compressors and power sources shall be provided to permit prompt re-activation of equipment in the event of failure.

(d) Compressed breathable oxygen shall—

(1) Include instructions for deployment and operation;

(2) Provide oxygen at a minimum flow rate of 1.32 cubic feet per hour per person;

(3) Include a means to readily regulate the pressure and volume of the compressed oxygen;

(4) Include an independent regulator as a backup in case of failure; and

(5) Be used only with regulators, piping, and other equipment that is certified and maintained to prevent ignition or combustion.

(e) The applicant shall prepare and submit an analysis or study demonstrating that the breathable air component will not cause an ignition.

(1) The analysis or study shall specifically address oxygen fire hazards and fire hazards from chemicals used for removal of carbon dioxide.

(2) The analysis or study shall identify the means used to prevent any ignition source.

§ 7.507 Air-monitoring components.

(a) Each refuge alternative shall have an air-monitoring component that provides persons inside with the ability to determine the concentrations of carbon dioxide, carbon monoxide, oxygen, and methane, inside and outside the structure, including the airlock.

(b) Refuge alternatives designed for use in mines with a history of harmful gases, other than carbon monoxide, carbon dioxide, and methane, shall be equipped to measure the harmful gases' concentrations.

(c) The air-monitoring component shall be inspected or tested and the test results shall be included in the application.

(d) The air-monitoring component shall meet the following:

(1) The total measurement error, including the cross-sensitivity to other gases, shall not exceed ± 10 percent of the reading, except as specified in the approval.

(2) The measurement error limits shall not be exceeded after start-up, after 8 hours of continuous operation, after 96 hours of storage, and after exposure to atmospheres with a carbon monoxide concentration of 999 ppm (full-scale), a carbon dioxide concentration of 3 percent, and full-scale concentrations of other gases.

(3) Calibration gas values shall be traceable to the National Institute for Standards and Technology (NIST) ''Standard Reference Materials'' (SRMs).

(4) The analytical accuracy of the calibration gas and span gas values shall be within 2.0 percent of NIST gas standards.

(5) The detectors shall be capable of being kept fully charged and ready for immediate use.

§ 7.508 Harmful gas removal components.

(a) Each refuge alternative shall include means for removing harmful gases.

(1) Purging or other effective procedures shall be provided for the airlock to dilute the carbon monoxide concentration to 25 ppm or less and the methane concentration to 1.0 percent

or less as persons enter, within 20 minutes of persons deploying the refuge alternative.

(2) Chemical scrubbing or other effective procedures shall be provided so that the average carbon dioxide concentration in the occupied structure shall not exceed 1.0 percent over the rated duration, and excursions shall not exceed 2.5 percent.

(i) Carbon dioxide removal components shall be used with breathable air cylinders or oxygen cylinders.

(ii) Carbon dioxide removal components shall remove carbon dioxide at a rate of 1.08 cubic feet per hour per person.

(3) Instructions shall be provided for deployment and operation of the harmful gas removal component.

(b) The harmful gas removal component shall meet the following requirements: Each chemical used for removal of harmful gas shall be—

(1) Contained such that when stored or used it cannot come in contact with persons, and it cannot release airborne particles.

(2) Provided with all materials; parts, such as hangers, racks, and clips; equipment; and instructions necessary for deployment and use.

(3) Stored in an approved container that is conspicuously marked with the manufacturer's instructions for disposal of used chemical.

(c) Each harmful gas removal component shall be tested to determine its ability to remove harmful gases.

(1) The component shall be tested in a refuge alternative structure that is representative of the configuration and maximum volume for which the component is designed.

(i) The test shall include three sampling points located vertically along the centerlines of the length and width of the structure and equally spaced over the horizontal centerline of the height of the structure.

(ii) The structure shall be sealed airtight.

(iii) The operating gas sampling instruments shall be placed inside the structure and continuously exposed to the test atmosphere.

(iv) Sampling instruments shall simultaneously measure the gas concentrations at the three sampling points.

(2) For testing the component's ability to remove carbon monoxide, the structure shall be filled with a test gas of either purified synthetic air or purified nitrogen that contains 400 ppm carbon monoxide, ±5 percent.

(i) After a stable concentration of 400 ppm, ±5 percent, carbon monoxide has been obtained for 5 minutes at all three sampling points, a timer shall be started and the structure shall be purged or carbon monoxide otherwise removed.

(ii) Carbon monoxide concentration readings from each of the three sampling instruments shall be recorded every 2 minutes.

(iii) The time shall be recorded from the start of harmful gas removal until the readings of the three sampling instruments all indicate a carbon monoxide concentration of 25 ppm or less.

(3) For testing the component's ability to remove carbon dioxide, the carbon dioxide concentration shall not exceed 1.0 percent over the rated duration and excursions shall not exceed 2.5 percent under the following conditions:

(i) At 55 °F (±4 °F), 1 atmosphere (±1 percent), and 50 percent (±5 percent) relative humidity.

(ii) At 55 °F (±4 °F), 1 atmosphere (±1 percent), and 100 percent (±5 percent) relative humidity.

(iii) At 90 °F (±4 °F), 1 atmosphere (±1 percent), and 50 percent (±5 percent) relative humidity.

(iv) At 82 °F (±4 °F), 1 atmosphere (±1 percent), and 100 percent (±5 percent) relative humidity.

(4) Testing shall demonstrate the component's continued ability to remove harmful gases effectively throughout its designated shelf-life, specifically addressing the effects of storage and transportation.

(d) Alternate performance tests may be conducted if the tests provide the same level of assurance of the harmful gas removal component's capability as the tests specified in paragraph (c) of this section. Alternate tests shall be specified in the approval application.

§ 7.509 Approval markings.

(a) Each approved refuge alternative or component shall be identified by a legible, permanent approval marking that is securely and conspicuously attached to the component or its container.

(b) The approval marking shall be inscribed with the component's MSHA approval number and any additional markings required by the approval.

(c) The refuge alternative structure shall provide a conspicuous means for indicating an out-of-service status, including the reason it is out of service.

(d) The airlock shall be conspicuously marked with the recommended maximum number of persons that can use it at one time.

§ 7.510 New technology.

MSHA may approve a refuge alternative or a component that incorporates new knowledge or technology, if the applicant demonstrates that the refuge alternative or component provides no less protection than those meeting the requirements of this subpart.

PART 14—REQUIREMENTS FOR THE APPROVAL OF FLAME-RESISTANT CONVEYOR BELTS

Subpart A—General Provisions

Subpart B—Technical Requirements

AUTHORITY: 30 U.S.C. 957.

SOURCE: 73 FR 80609, Dec. 31, 2008, unless otherwise noted.

Subpart A—General Provisions

§ 14.1 Purpose, effective date for approval holders.

This Part establishes the flame resistance requirements for MSHA approval of conveyor belts for use in underground coal mines. Applications for approval or extensions of approval submitted after December 31, 2008, must meet the requirements of this Part.

§ 14.2 Definitions.

The following definitions apply in this part:

Applicant. An individual or organization that manufactures or controls the production of a conveyor belt and applies to MSHA for approval of conveyor belt for use in underground coal mines.

Approval. A document issued by MSHA, which states that a conveyor belt has met the requirements of this Part and which authorizes an approval marking identifying the conveyor belt as approved.

Extension of approval. A document issued by MSHA, which states that a change to a product previously approved by MSHA meets the requirements of this Part and which authorizes the continued use of the approval marking after the appropriate extension number has been added.

Flame-retardant ingredient. A material that inhibits ignition or flame propagation.

Flammable ingredient. A material that is capable of combustion.

Inert ingredient. A material that does not contribute to combustion.

Post-approval product audit. An examination, testing, or both, by MSHA of an approved conveyor belt selected by MSHA to determine if it meets the technical requirements and has been manufactured as approved.

Similar conveyor belt. A conveyor belt that shares the same cover compound, general carcass construction, and fabric type as another approved conveyor belt.

§ 14.3 Observers at tests and evaluations.

Representatives of the applicant and other persons agreed upon by MSHA and the applicant may be present during tests and evaluations conducted